IoT Project Logbook

22 January 2020 16:27

Project guidance document: https://www.cs.kent.ac.uk/people/staff/djb/co838/LOCAL-ONLY/CO838_A2_A3.pdf

Logbook guidance:

- we want you to capture your design thinking and design processes.
- We also want to read your evaluations of the outcomes of your thinking and processes, even if your evaluation is that you rea lise with the benefit of hindsight that you took a wrong turn along the way, or undertook a task that was ultimately unrealis tic or impractical
- Each time you do some work on your IoT project, whether or not it involves practical computing, record the date and time of t he work. Before you start, specify your objectives: what you intend to have completed by the end. Before you end, enter comme nts on your success or otherwise in achieving your objectives
- Any decisions you take should be justified: as often as possible you should propose alternative solutions to problems and the n explain the reasons why you choose one particular solution
- All throughout your study you will encounter things that you don't understand. Make a note of such things in your logbook and then make a point of finding answers which you should also record there.
- You will generate all sorts of records and exhibits as you proceed through this project. Where these are readily available, t here is no need to rewrite them for your logbook. If short, just stick them (literally) in the log book.
- Note any unusual behaviour either of the physical device or the software you develop.
- Your logbook will be important both as your own personal record of activity and as guide to your supervisor about your work f or this project

End evaluation:

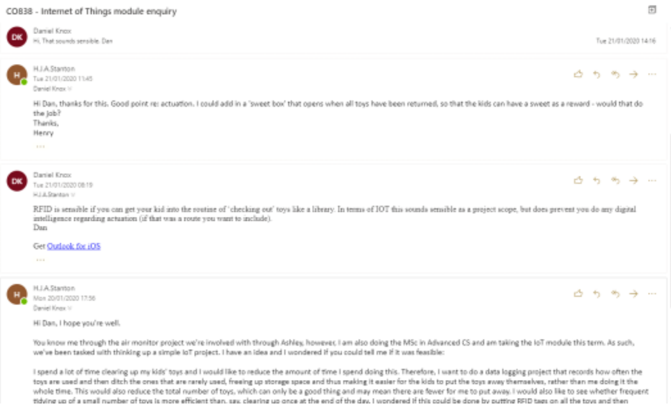
Reflect. At the end of this project, evaluate it as a whole. As a minimum, you should complete the following starter sentences:

– How I approached this piece of work: ....
– What I found fairly easy was ....
– What I found most difficult was ....
– If I were to do the work again, I would do the following differently: ....
– What I learned is ...
– I would like specific feedback on ...
– I felt this way about the work ....

Project proposal:

21/01/2020
0 I0
+ wondered if this could be done by putting RFID tags on all the toys and then putting RFID readers on the storage boxes, so that I could record each time a toy was taken out of a box. The logged data would need to be transmitted to some central point, where I could then do some analysis of toy use and decide which ones to cull.
Add in a 'sweet box' that opens when all toys have been returned, so that the kids can have a sweet as a reward

In response Dan said:



CO838 - Internet of Things module enquiry

Daniel Knox
Hi, That sounds sensible. Dan
Tue 21/01/2020 14:16

H.J.A.Stanton
Tue 21/01/2020 11:45
Daniel Knox

Hi Dan, thanks for this. Good point re: actuation. I could add in a 'sweet box' that opens when all toys have been returned, so that the kids can have a sweet as a reward - would that do the job?
Thanks,
Henry

Daniel Knox
Tue 21/01/2020 08:19
H.J.A.Stanton

RFID is sensible if you can get your kid into the routine of 'checking out' toys like a library. In terms of IOT this sounds sensible as a project scope, but does prevent you do any digital intelligence regarding actuation (if that was a route you want to include).
Dan

Get Outlook for iOS

H.J.A.Stanton
Mon 20/01/2020 17:56
Daniel Knox

Hi Dan, I hope you're well.

You know me through the air monitor project we're involved with through Ashley, however, I am also doing the MSc in Advanced CS and am taking the IoT module this term. As such, we've been tasked with thinking up a simple IoT project. I have an idea and I wondered if you could tell me if it was feasible:

I spend a lot of time clearing up my kids' toys and I would like to reduce the amount of time I spend doing this. Therefore, I want to do a data logging project that records how often the toys are used and then ditch the ones that are rarely used, freeing up storage space and thus making it easier for the kids to put the toys away themselves, rather than me doing it the whole time. This would also reduce the total number of toys, which can only be a good thing and may mean there are fewer for me to put away. I would also like to see whether frequent tidying up of a small number of toys is more efficient than, say, clearing up once at the end of the day. I wondered if this could be done by putting RFID tags on all the toys and then

Sc

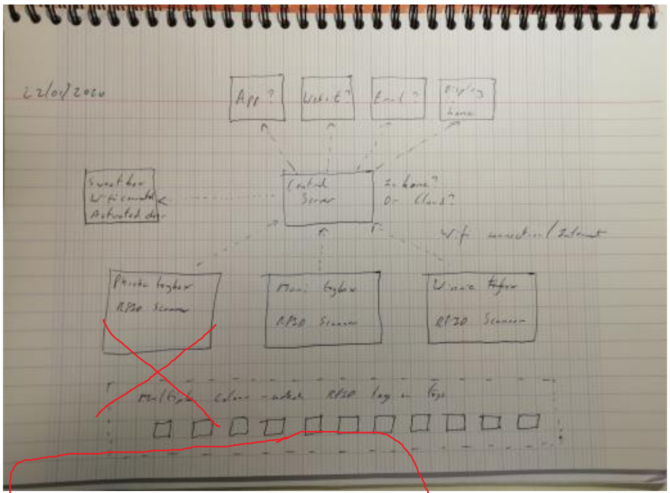
reen clipping taken: 22/01/2020 17:08

22/01/2020
Additional to the above:

- Have a central point that gathers data on status of all toy boxes
- Colour code rfid tags for each toy box -
- Have an additional set of tags for each box of toys in each kids' room - communicates via wifi that all items allocated to that box are in the correct place
- Some items often get lost under sofas etc - set heuristic of 90% of toys for any box should be in the room
- send reports of location of toys in wrong boxes
- Produce reports of which child's box is most often complete - emailed? Sent to an app on phone? Displayed on local display? Sent to a web page?
- Produce bar chart display to motivate children, with weekly reward
- Sweet box is not that healthy, but could maybe be changed to a 'green light' to say to a parent that the kids can watch some tv
- An alt would be to see a real time display of a bar chart of progress of toys being put away or of specific kids' toy boxes being filled up - effectively gameify it - motivating for kids
- Could have a real time display and an overall display for individual kid's performance over course of week
- Data analysis of least used toys to help parents cull, or rotate toys
- Doesn't work for small things eg lego
- Problems:
  - Allows for free riders and discourages altruistic behaviour ie. The kids helping each other out / working as a team
- Reports on a phone might help parents see if kids in their bedroom are in fact putting toys away, rather than messing around
- Need functionality to monitor if, at the same time as toys are being put away, other ones are also being pulled out
- Rfid tags are robust, simple and cheap

Thoughts on architecture:

- RFID tag on each toy
- ? Rfid reader on each toy box with wireless connectivity.
- ? Battery powered? Or mains? Or solar? Any way of powering over wireless? Or PPoE?
- ? Central server to receive logged data? Cloud server?
- ? App/website/display/email to show results
- ? 'Sweet box' connected via wifi with some actuation - motor to open door or spring loaded door with electromagnet catch (the latter would have to switch on whenever door of box is closed - how?

- 

Once you are working on a computer system, the temptation to type in bits of code 'off the top of your head' or make 'quick a nd dirty' adjustments in succession, without recording the effects, is almost irresistible

31/01/2020 - Meeting with David Barnes
Went to check project with David Barnes - very enthusiastic but queried what would happen if some toys were lost.
- I suggested a 90% threshold for toys to be in the box, in order for sweets to be released

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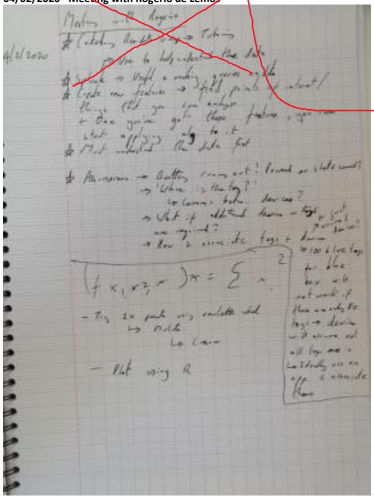
04/02/2020 - Meeting with Rogerio de Lemos



Meeting with Rogerio

4/2/2020

* Catching [illegible] → [illegible]
→ Use to help understand the data
* Splunk → Stuff + making queries on the data
* Create new features → [illegible] points of interest/ things that you can analyse
+ Once you've got these features, you can start applying alg. to it
* Must understand the data first
* Assumptions → Battery running out? Permanent or [illegible]?
→ 'Where is the toy?'
→ Losing battery devices?
→ What if additional devices – toys → just [illegible] devices? are required?
→ How to associate toys + devices

$$(f\ x_1, x_2, \ldots)x = \sum x_i^2$$

– Try 2x peak using [illegible]
→ [illegible]
→ [illegible]

– Plot using R

→ 100 + live toys for the box will not work if there are only 80 toys → device will assume not all toys are in → Ideally use an app to associate them

5/02/2020

- Security?
- Actuation plan
- Multiple devices?
- Rechargable devices
- App to register new tags/toys with a sensor
- Fault management?

- **06/02/2020**
-
-

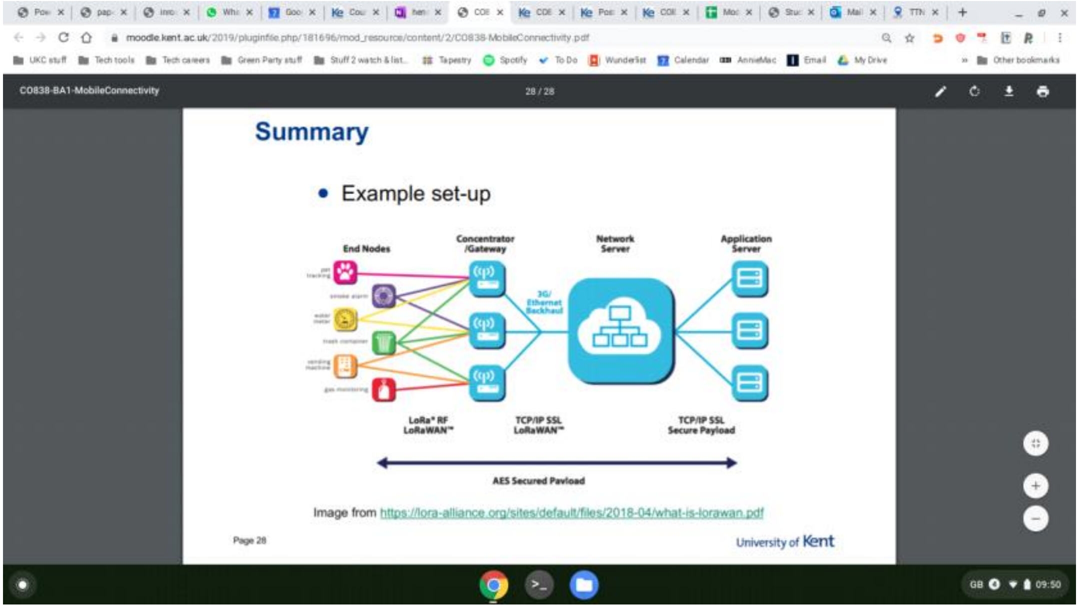
-

- Toys are varied. A lot of toys this won't work for e.g. Jigsaw pieces; bits from board games
- e.g. pens - would we put tags on them? Would be nice to have them put away but they get thrown out all the time - how to deregister them from the device before chucking out?
-
-

7/2/2020

What about battery consumption? BLE can be months-years long for a battery

- If there's an app, could it warn re: battery running out on a device?
- Connectivity – Bluetooth classic – only 7 devices can connect
- BLE can be up to 6000 thought
- Zigbee – can do 64000
- Issue – NFC – v short range, would this be better, cos then kids would need to scan each item in – might be satisfying for them and avoid problems of devices scanning wrong toys
- So, Zigbee or BLE – need to think about how devices need to communicate? What topology works best? How to add devices? What works best in terms of Power requirements?
-


moodle.kent.ac.uk/2019/pluginfile.php/181696/mod_resource/content/2/CO838-MobileConnectivity.pdf
CO838-BA1-MobileConnectivity
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Summary

- Example set-up

Image from https://lora-alliance.org/sites/default/files/2018-04/what-is-lorawan.pdf

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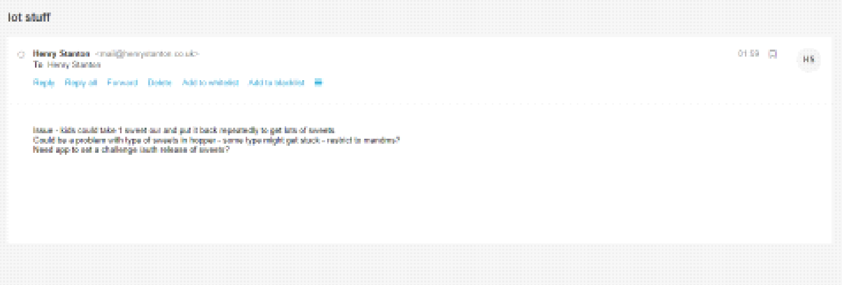
University of Kent

10/02/2019
Middle of the night thought:



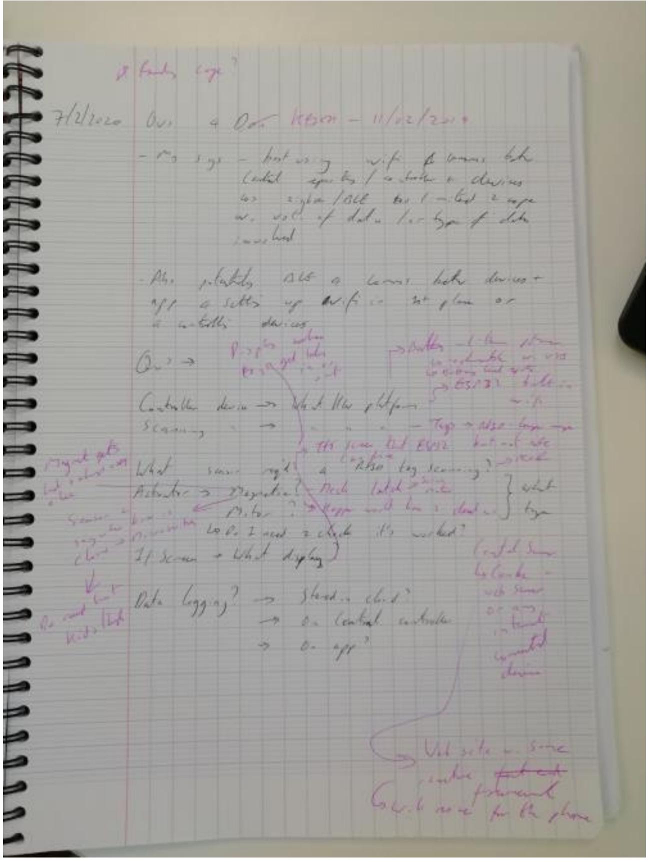
Iot stuff

Henry Stanton <mail@henrystanton.co.uk>
To: Henry Stanton
01:59

Reply Reply all Forward Delete Add to whitelist Add to blacklist
HS

Issue - kids could take 1 sweet out and put it back repeatedly to get lots of sweets
Could be a problem with type of sweets in hopper - some type might get stuck - restrict to m&m's?
Need app to set a challenge b4 release of sweets?

11/02/2020



a faraday cage?

7/2/2020 Over to Dan [illegible] – 11/02/2020

- [illegible] – best using wifi to connect both central [illegible] / controller & devices [illegible] zigbee/BLE [illegible] – [illegible] [illegible] data / [illegible] type of data involved

- Also potentially BLE to connect both devices + app to setting up wifi in 1st place or to controlling devices

Qu? →

Controller device → What H/w platform

Scanning → " " " – Tags → RFID [illegible]

What sensors reqd? + RFID tag scanning?

Actuator → Magnetic? – Mech latch

Motor? → Hopper [illegible]

Do I need to check it's worked?

If Screen → What display

Data logging? → Stored in cloud?
→ On central controller
→ On app?

Web site in some reactive ~~[illegible]~~ framework
Could resize for the phone

Meeting with Keith in the Shed 11/02/2020

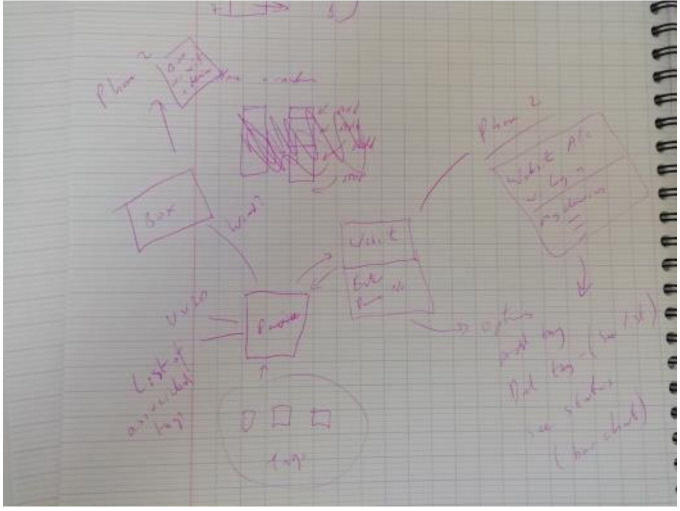
- Device - ESP32 works well because RFID scanner can be connected and it has wifi built in
- Runs a lithium polymer battery, rechargable by USB and has battery life monitoring, so that functionality could be included in any app
- ESP32 can also drive a TFT colour display - can be used for some sort of bar chart or other 'fun' display to gameify/incentivise kids
- ★ Need to check with Dan what RFID tech to use - not NFC as needs to be over a greater distance
    - ASSUMPTION: Toys left near box will probably appear to be in the box. Unless toybox is a faraday cage, this could be a proble m….
- For system - use a web server to gather data from device(s) & create web app with some sort of reactive framework that will resize on a mobile phone browser, so no need to build a phone app
- For actuating device - sweet box / hopper:
    - Hopper is nice idea but leads to problems with jamming/inconsistent sweet sizes and inconsistent numbers of sweets
    - Sweet box better if kids can be trusted to only take one
    - Not with electromagnetic catch as whenever locked, it's always using energy and also gets hot

- So: make a mechanical latch from a servo motor microswitch
- Also needs a sensor made from microswitch to say if box is closed (and therefore needs latch closing)

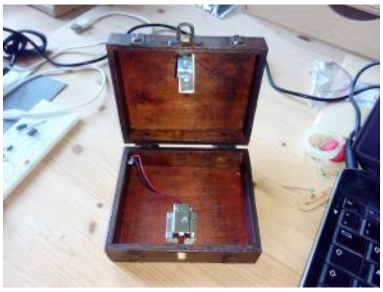
12/02/2020

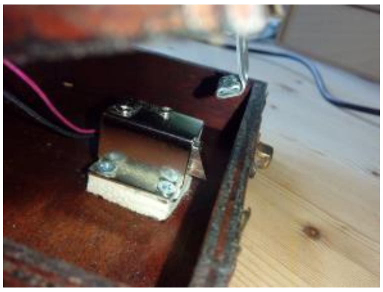
For security, can the rfid scanner scan other types of tag eg those in a credit card or phone? Is that a security risk?
https://techtutorialsx.com/2017/05/19/esp32-http-get-requests/

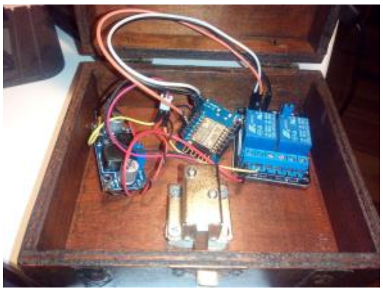
Rough plan of how it could all work (in two phases):



Arduino lock box project: https://www.instructables.com/id/Private-Lock-Box-With-Pin-Code-Bluetooth-Activated/
https://www.instructables.com/id/IoT-Lockbox/



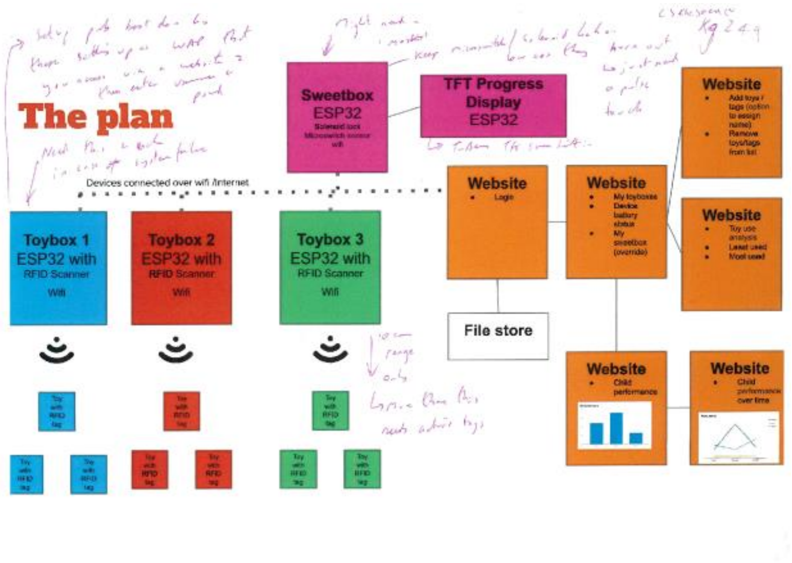




13/02/2020

- Discussed how toybox scanner devices should connect to home wifi.
  - Initially considered UPNP but Dan suggested them setting themselves up as Access points on power up, so that they could be ef fectively accessed from a web browser, in the same way that things like the Amazon dot do
  - So then on the website, user can enter SSID & password for home wifi
- RFID tags are a problem - passive ones have range limited to 10 cms. More than that requires them to be active with a battery, which isn't possible for my purposes.
  - This is a major issue - really didn't want the kids to have to scan the items.
  - If they do have to do this, I'll need some feedback device to indicate to them that it has been entered e.g. a 'beep' sound o r a green LED light?
- The sweet box latch will require too much power for the ESP32, so I'll need to use a MOSFET transistor, to provide the current, without the ESP32 being involved
  - Also, the latches will need just pulse power and should be set to 'low'. Apparently they are often set to high and people the n hold them down and they burn out. Or he may have been talking about the microswitch sensor.
- TFT Screen should be able to run off the sweet box esp32. Keith says you can get some displays that are integrated with the esp32
- I had considered the scanners interacting directly with the sweet box, but Dan reckons better to go via web server

- For video demo, will try to get scanner to recognise rfid tags and show up on the serial output screen
- Need to consider system failure. What happens if the website/internet go down?
  - ★ **Need toybox scanners to cache state and protocol for re-establishing control after the event**
- Mifare classic protocol - can't remember what this was about, but Dan suggested it for something…


The plan
Sweetbox ESP32
Solenoid lock
Microswitch sensor
wifi
TFT Progress Display ESP32
Devices connected over wifi /internet
Toybox 1 ESP32 with RFID Scanner Wifi
Toybox 2 ESP32 with RFID Scanner Wifi
Toybox 3 ESP32 with RFID Scanner Wifi
Toy with RFID tag
Website
Login
Website
My toyboxes
Device battery status
My sweetbox (override)
Website
Add toys / tags (option to assign name)
Remove toys/tags from list
Website
Toy use analysis
Least used
Most used
File store
Website
Child performance
Website
Child performance over time
Kg 2 4 9
10 cm range only
Might need - microswitch
Need this in case of system failure

RFID - investigations into limitations:

- ★ Can we get passive tags with more than 10cm range?

1. Will they be affected by being stuck on metal toys?
   For example, if an RFID system operates at a lower frequency, it has a slower data read rate, but increased capabilities for reading near or on metal or liquid surfaces. If a system operates at a higher frequency, it generally has faster data transfer rates and longer read ranges, but more sensitivity to radio wave interference caused by liquids and metals in the environment.

   From <https://www.impinj.com/about-rfid/types-of-rfid-systems>

   The read range of passive UHF systems can be as long as 12 m, and UHF RFID has a faster data transfer rate than LF or HF. UHF RFID is the most sensitive to interference, but many UHF product manufacturers have found ways of designing tags, antennas, and readers to keep performance high even in difficult environments. Passive UHF tags are easier and cheaper to manufacture than LF and HF tags.

   From <https://www.impinj.com/about-rfid/types-of-rfid-systems>

   Ultra-high frequency (UHF) RFID
   The UHF frequency band covers the range from 300 MHz to 3 GHz. RAIN RFID systems comply with the UHF Gen2 standard and use the 860 to 960 MHz band. While there is some variance in frequency from region to region, RAIN RFID systems in most countries operate between 900 and 915 MHz.

   From <https://www.impinj.com/about-rfid/types-of-rfid-systems>

   13.56 MHz – High Frequency (HF) & Near-Field Communication (NFC) – A medium wavelength with a typical read range of about 1 centimeter up to 1 meter. This frequency is used with data transmissions, access control applications, DVD kiosks, and passport security – applications that do not require a long read range.
   https://blog.atlasrfidstore.com/active-rfid-vs-passive-rfid

   ### 13.56 MHz. High Frequency (HF) Passive RFID Tags

   Maximum read distance of 1.5 meters (4 foot 11 inches) - usually under 1 meter (3 feet) and you can use a single or multi port reader plus custom antennas to extend the read range to longer tag read distances or a wider RFID read zone. To obtain more than 1 meter you need a reader with more than 1 watt RFID output power. SkyRFID can supply 13.56 readers with RF power outputs up to 10 watts for multiple antenna connections and over 1 meter tag read distances.

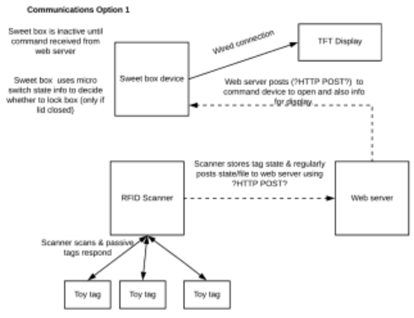
   From <https://skyrfid.com/RFID_Range.php>

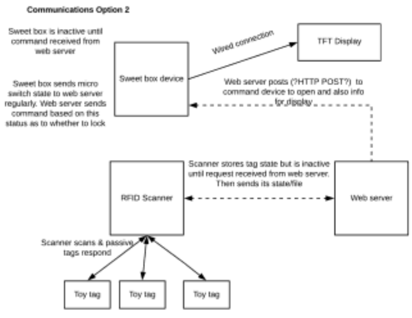
   Conclusion: HF is correct range for me. UHF is too long range to be useful

- But larger antenna give greater range. We are limited by range
- Some evidence that HF passive tags can go further, albeit with a more powerful scanner signal
- Hard to find concrete information on it though.
- However, 1 foot does seem to be quite viable. 1'x1'x1' toy box probably quite viable. - these are what we currently have: https://www.amazon.co.uk/dp/B079VWBXGM/ref=cm_sw_r_wa_apa_i_0WArEbA1X45GN

- (32 x 37 x 32 cm (12.59 x 14.56 x 12.59 inches), so if we can get them to reach a foot, that would probably be ok (depending on where I site the scanner in the box - centre base of box would produce most reliable results, but difficult to access for charging, so top of one side is probably better, in which case max diagonal distance is 58.44cm (23 inches - almost 2 feet) from top corner to opposite bottom corner. More likely it would be sited in middle of top of one side, so max diagonal distance to base is 48.9cm (19.25 inches) - more acceptable. Even better if placed in middle of long side.
- This site https://www.rfidup.com/8-things-you-need-to-know-about-hf-1356-mhz-rfid-tag/ suggests HF can go up to 50cm and is more reliable than UHF. HF also less vulnerable to interference and has lower power requirements. Also, tags are less bulky and don't require metal - can just be printed on stickers, which would be better for putting on toys
- ★ PROBLEM: This site says HF can only do 20 tags at a time vs UHF doing 200 at a time - need to check with Dan

Possible communications arrangement?


Communications Option 1
Sweet box is inactive until command received from web server
Sweet box uses micro switch state info to decide whether to lock box (only if lid closed)
Sweet box device
Wired connection
TFT Display
Web server posts (?HTTP POST?) to command device to open and also info for display
Scanner stores tag state & regularly posts state/file to web server using ?HTTP POST?
RFID Scanner
Web server
Scanner scans & passive tags respond
Toy tag
Toy tag
Toy tag


Communications Option 2
Sweet box is inactive until command received from web server
Sweet box sends micro switch state to web server regularly. Web server sends command based on this status as to whether to lock
Sweet box device
Wired connection
TFT Display
Web server posts (?HTTP POST?) to command device to open and also info for display
Scanner stores tag state but is inactive until request received from web server. Then sends its state/file
RFID Scanner
Web server
Scanner scans & passive tags respond
Toy tag
Toy tag
Toy tag

Things to do (note clear delineation of extension tasks - not all of this will be possible in time available):

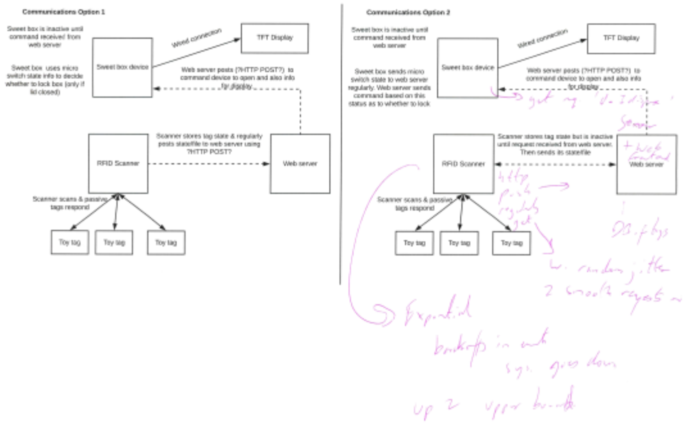
Things to do:	
	Make components list
Scanner	Get components together
	Get scanner to see tags
	Get scanner to feedback on succesful scan - LED or beep
Extension	Get a box for the scanner to sit in
	Get scanner to store number of tags with timestamp
Extension	Get scanners to act as APs on startup (with reset option)
Extension	Set up web page / form for entering SSID and pasword for wifi
	Sort some communication routine for sending data to website - wait for web server to poll or just post info every few seconds?
Extension	Sort some sort of loss of connection to web server protocol (If web server or Internet goes down)
Website	Setup web server system (uni host?)
	Sort file store for respective toybox scanners
	Create logic for handling state updates and sending commands to sweet box
	Setup/find CSS template / reactive framework
Extension	Sort sending data for TFT display
Extension	make account / home web page
Extension	make db for storing account info
Extension	Make web page for registering devices (with naming facility)
Extension	Make web page for registering and deleting toy tags to/from device (with naming facility for toys)
	make device status web page (with numbers of toy tags per device and battery status)
Extension	make analysis web page - child performance (really toybox performance) / toy performance - with graphs?
Extension	Alert system if unrecognised toytags are in a toybox?
Sweetbox	Get a box
	Get sensor on box
	Get latch on box and latching
Extension	Get LED/speaker on box
	Connect above to ESP32
	Get ESP32 to actuate latch
	Get ESP32 to light up LED/Beep
	Get ESP32 to lock if switch closed
Extension	Connect display to sweetbox ESP32
Extension	Get display to show bar chart / web page image of bar chart?

14/02/2020

To take to market:

- QR codes on tags to make toytag registration straightforward - using an app. Otherwise too much hassle for users to type in numbers of each toytag each time they want to reg a toy with a scanner
- To improve range, could have two scanners in a box
- May even need to sell boxes with scanners built in, rather than free standing scanners?

Chat with Dan and Keith: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Wired connection
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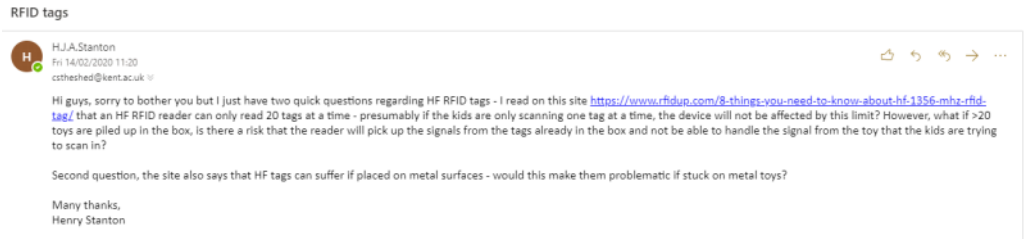
Web server posts (?HTTP POST?) to command device to open and also info for display
get reg 'v. I d...' Server
Scanner stores tag state but is inactive until request received from web server. Then sends its statefile
RFID Scanner
+ Web front end
Web server
http push regularly get
DB of toys
Scanner scans & passive tags respond
Toy tag
Toy tag
Toy tag
w. random jitter 2 smooth requests
Exponential backoffs in case sys. goes down up 2 upper bound

- Server is a server plus web front end (not just a web server!) plus DB to store devices/toys/
- Toybox scanner maintains state
- 'Pushes' state regularly to server
- Polls server regularly using http get requests - 'Are there any updates?' e.g. tags added or deleted
- Probably more straightforward than MQTT, which would be more immediate, but prob not as necessary
- Should be ok in terms of energy consumption
- However, if we have too many toybox devices on one home network/one server, could get serious slow down on the server
    - Can help with this by using **random jitter** for get requests - avoid multiple requests all at same time by adjusting frequency of get requests by random number of milliseconds, which smoot hs out server load
- Sweet box will also need to poll requiarly 'Shall I unlock?'. This will also drive TFT display, so makes sense for this to be plugged into power socket
- Sweet box handles logic of whether to lock based on whether sensor says door is closed. So would:
    - Poll 'should I unlock?'
    - If response is 'yes'
    - Unlocks and waits till microswitch sensor shows box has been opened.
    - Once microswitch is again activated, sweetbox locks latch
- So in conclusion, devices know location/IP address of server, but server doesn't know what devices are out there.
- In addition, claims that HF RFID can do 50cm-1 metre are simply not true in real world unless you have very big antennas.
- Could be possible with v expensive UHF antennas and, more to the point, v expensive UHF readers. But could be e.g. £500 for tags+device - so possible in the future
- Suggested 2 or more scanners in same box, but this actually confuses situation as 2 x signals are then sent back by tag and would be read twice by readers, which would effectively mean 4 signals read in total, rather than just 1! Or/And they create EMI interference and make signals worse
- So will have to get kids habituated to scanning items and will therefore need a feedback device - buzzer and or light - ADDITIONAL COMPONENT. In a way, this may not be a bad thing - might make more sense to the kids to actually see an event as a consequence of putting toy in box. May otherwise feel all a bit magical otherwise.
- System failure:
    - Exponential backoffs - in the event that server crashes, goes down, none of the devices will mind - they'll keep sending get requests out, but do so using 'Exponential backoffs' ie delaying exponentially each time they don't get a response (up to e.g. 1 whole day); this way don't t end up spamming the server when it comes back online and don't waste lots of energy
- Mifare classic protocol is the comms protocol that the RFID tags will use, based on an ISO standard



RFID tags

H.J.A.Stanton
Fri 14/02/2020 11:20
cstheshed@kent.ac.uk

Hi guys, sorry to bother you but I just have two quick questions regarding HF RFID tags - I read on this site https://www.rfidup.com/8-things-you-need-to-know-about-hf-1356-mhz-rfid-tag/ that an HF RFID reader can only read 20 tags at a time - presumably if the kids are only scanning one tag at a time, the device will not be affected by this limit? However, what if >20 toys are piled up in the box, is there a risk that the reader will pick up the signals from the tags already in the box and not be able to handle the signal from the toy that the kids are trying to scan in?

Second question, the site also says that HF tags can suffer if placed on metal surfaces - would this make them problematic if stuck on metal toys?

Many thanks,
Henry Stanton

Screen clipping taken: 14/02/2020 11:22

List of components required:

- Buzzer
- Green LED x2
- ESP32 x 1 with RFID scanner and wifi and built in Lithium polymer battery
- ESP32 x 1 with built in TFT Display - TBEAM model?
- HF 13.56 Mhz RFID Mifare Classic tags x 50
- MOSFET
- Solenoid latch

- Microswitch

18/02/2020
Looking at what needs doing for video:

- RFID scanner able to scan and record RFID tags
- RFID scanner connects to wifi
- Server created and hosted
- RFID scanner connects via http (POST or PUT?) to send state
- Server receives and updates stored info (csv file? or DB - mysql?)
- Sweet box device polls server for (http GET?) to check on whether to unlock
- Server is able to respond via http when box should be unlocked - probably don't need a functioning actual sweet box, just an ESP32 device that can show reception of server command

Therefore, now looking at server and hosting options.

- I have a hosting account I could use with 1and1.co.uk. I can put a mysql DB on but don't actually know if I can put server files on there, without paying more. Also don't know how scalable this is
- Obvs, scalability is not an issue atm, but an alternative is AWS, which is free on a low level and, using Elastic Beanstalk, can scale without me having to do anything. If this was a commercial project, this would be very useful. https://happycoding.io/tutorials/java-server/hosting-aws
- Next issue is type of server to make. Loads to choose from, eg. Node.js or just Java. Since interaction with server is via http, it really comes down to what's easiest to implement, as input and output will be using http, irrespective of server platform.
- Also, web front end needs to be responsive, so that it resizes for mobile phones, to save me building an app, so having looked at a few responsive frameworks (Siiimple, bootstrap. Pure, Semantic UI, Foundation….) I'm going with Bootstrap because it's pretty easy to set up and has a huge amount of support/resources

Useful resources for this stuff:

- Loads of ESP32 resources: http://esp32.net/
- How to make and host a java server: https://happycoding.io/tutorials/java-server/ and also https://developer.mozilla.org/en-US/docs/Learn/Common_questions/set_up_a_local_testing_server
- Web dev explained: https://www.freecodecamp.org/news/the-absolute-beginners-guide-to-learning-web-development-in-2018-d87ba925549b/#part3
- How to turn ESP32 into an AP (useful for network discovery when you add a new scanner device) https://randomnerdtutorials.com/esp32-access-point-ap-web-server/
- How to get ESP32 to connect to server using GET: https://learn.sparkfun.com/tutorials/esp32-thing-hookup-guide/arduino-example-wifi
- **HTTP PUT vs POST https://restfulapi.net/rest-put-vs-post/ - MIFARE Classic has 16 byte serial number reserved for each tag, so assuming this is readable by scanner, we can use this for list of tags. Therefore, assuming limit of 100 toys per box, max size of data to send to server is 16 x 100 = 1600 bytes. POS T requests go up to 2000 bytes - could be tight - is 100 toy limit realistic?! Kids could go crazy and scan loads of toys and pile them up/put them 'around' the box, so limit could be exceeded.**
- HTTP GET with ESP32: https://techtutorialsx.com/2017/05/19/esp32-http-get-requests/
- HTTP PUT with ESP32: https://www.dfrobot.com/blog-1212.html

Question: What are the actual data that need passing:

- From RFID scanner to server
- From server to RFID scanner
- From Sweetbox device to server
- From server to Sweetbox device

Question:

- What data need storing on server
- What format?
- How/what will we update?

Screen clipping taken: 18/02/2020 20:17

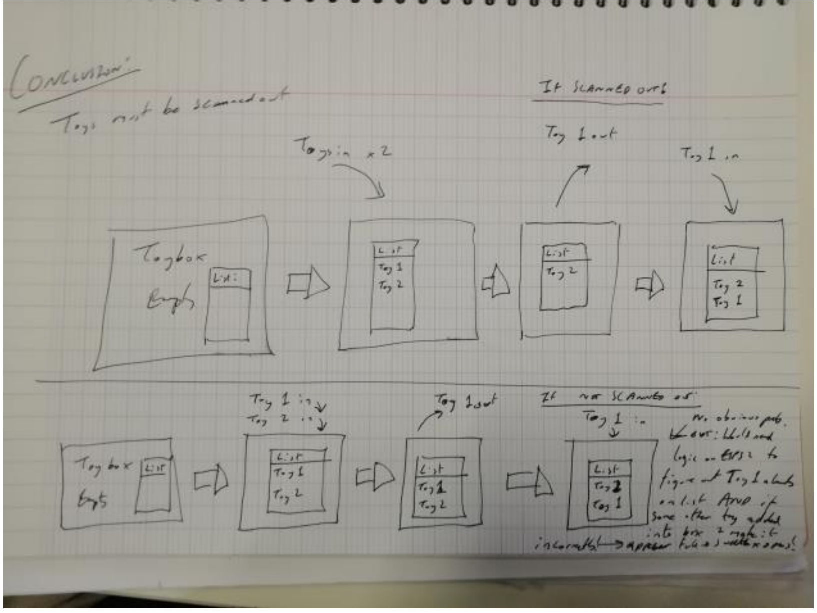
Need to ensure that a response to a sweetbox request does not unlock ALL sweetboxes registered with the server

- Unique ID for each sweetbox to be included in initial request from sweetbox and then also included in response? Sweetbox devi ce has to check if its ID is included in response?
- Or would multithreading overcome this?
- **Me being stupid. The response will go to unique IP of requesting device**

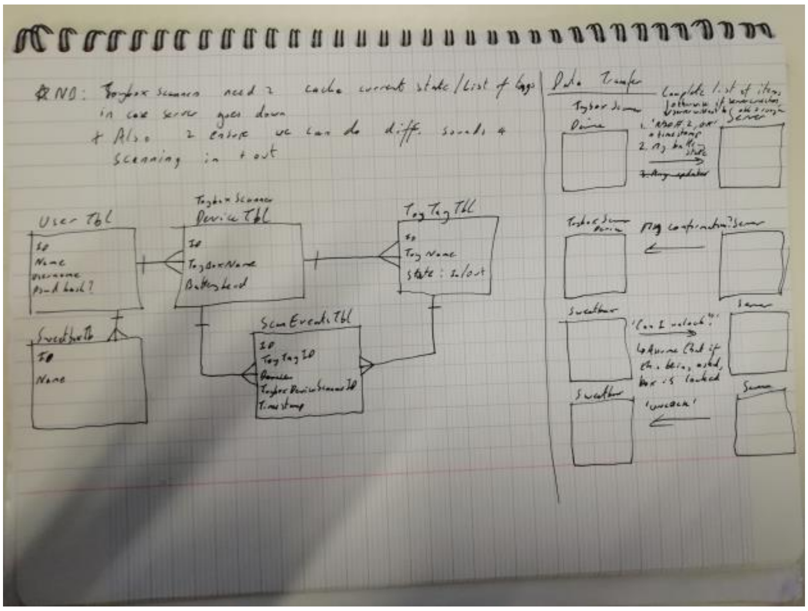
Data required:

- **When Toybox scanner device communicates it must send entire list of tags in box, so that if server goes down for some period of time, it can re-establish accurate list of devices**
- Also, scanner device will need to store cache file each time it sends update, so that if server crashes, accurate list is maintained
- Also, on server, will need logic to check sent list vs current state and update DB accordingly
- Scanner device will simply maintain list of all tag IDs that have been scanned in. This may include toy tags from other boxes. Server logic will check for this and can put alert on website
- I have just realised that the kids will not only have to scan in but also scan out toys. This is a lot more problematic. Very hard to see how kids can be encouraged to remember to do this….
  - Maybe a fun noise when scanning out e.g. elephant horn or trumpet toot?
  - But will need alt. noise for scanning in, so that they're incentivised to do the scanning out bit
- I think toybox scanners won't need to poll for 'any updates' as the list of toy tags registered to specific device will be kept by server. That way it will be the server logic that figures out whether an incorrect tag has been put in
- Although, worth noting that a useful extension could be to have an alert sound on the toybox scanners if an incorrect toy is scanned in - that way, possibly the child would find the correct box to put it in. Maybe this is too much sophistication for younger kids though
- How to get a timestamp for each scan event. Need it to be coordinated with other toybox devices, so their scans can be synced (so that we can do useful analysis of most used toys etc) and how is this time maintained during battery outage?! NTP?

Do toys have to be scanned out as well as in? Answer yes :(



DB Structure and key data transfer



NB: Toybox scanners need 2 cache current state/list of tags in case server goes down + Also 2 ensure we can do diff. sounds 4 scanning in + out

Consideration of communication protocol between devices and server:

- Options: HTTP, MQTT and Websockets
- Type of data to be communicated: Short commands (e.g. "can I open?", "yes", "I am closed", "here is some toy tag info", "mess age received"), infrequently, no real security considerations
- Websockets is designed for continuous data being pushed by a device - not applicable here - unnecessarily complicated; not appropriate to our data transmission reqs
- HTTP is straightforward to implement, human readable (easier for debugging) and uncomplex
- MQTT is probably best if I had the time to get my head around it - Better for battery life, 93x quicker than http, lower bandwidth, better reliability with a range of delivery guarantees than http
- https://medium.com/mqtt-buddy/mqtt-vs-http-which-one-is-the-best-for-iot-c868169b3105

19/02/2019

Procurement: https://booking.cs.kent.ac.uk/reserve

- **Ordered:**
  - Solenoid latch - https://www.banggood.com/12V-DC-0_43A-Cabinet-Drawer-Electric-Door-Lock-Assembly-Solenoid-Lock-27x29x18mm-p-1048590.html?akmClientCountry=GB&&cur_warehouse=CN
  - Needs a relay? - We'll see if Keith/Dan have any latch type things lying around in the shed

- **Reserved:**
  - 2 x esp32
  - RFID scanner
  - 3 x rfid tags

- **Other items that should be lying around the shed:**
  - Green LED x2
  - MOSFET
  - Microswitch

- **To order in the future:**
  - ESP32 x 1 with built in TFT Display - TBEAM model?

To get music on the toybox scanner e.g. a lion roar or hey duggie music (to incentivise kids to scan toys as they take them out of box), will need a speaker:

- For this, the ESP32 requires a DAC (it has two - 8-bit channels - Channel 1 goes to GPIO25, channel 2 to GPIO26)
- Will also need an amp
- Will also need a speaker
- Will also need to be able to store sound files - ESP32 with sd card slot (Some do have)? or an sd card reader with spi connectivity
- Some resources:
  - https://www.xtronical.com/testing-the-dacaudio-hardware/
  - https://www.xtronical.com/basics/audio/digitised-speech-sound-esp32-playing-wavs/
  - https://www.xtronical.com/basics/audio/dacs-on-esp32/

Does ESP32 have real time clock? Or can it link to NTP? Could be first thing it does when it boots up?

- Will need to be able to link to Internet to get NTP time, or get it via server - https://randomnerdtutorials.com/esp32-ntp-client-date-time-arduino-ide/
- If Internet goes down, on board clock can keep time
- But if battery runs out, does it need RTC? Or have **a standard boot sequence to coordinate time**

Server and DB implementation on AWS

Did try personal host (1and1.co.uk) but I don't pay enough. Can get mysql db, but not java server
AWS RDS (DB manager):
Instance identifier: ToyboxDB
Master username: admin
Master pswd: hshs…
Access key ID: AKIAI6LM4CU3DORW7OQQ
Secret access key: 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

From <https://console.aws.amazon.com/iam/home?>

From <https://console.aws.amazon.com/iam/home?>

From <https://console.aws.amazon.com/iam/home?>

Having set up a DB instance, I am happy to acknowledge that this is not a straightforward process

There are a few problems with having HTML inside Java:

- It's hard to edit. Even this basic HTML is annoying to work with.
- It's hard to format with proper indentation (which makes it hard to edit).
- It's hard to debug: how do you find a typo in the middle of a bunch of String values?

Instead of writing a Java program that contains HTML, JSP allows you to write HTML that contains Java code.

From <https://happycoding.io/tutorials/java-server/jsp>

22/02/2020

- Bloody server crap. Nothing works as it's supposed to.
- AWS is pigging complicated and tutorials are great but then a specific servlet package can't be found.
- Trying Eclipse with AWS plugin. Completely diff file structure to what I'm expecting presented
- Entire day wasted!

23/02/2020

- Am just going with AWS tutorial/case study and will try to adapt that to my requirements
-

https://docs.aws.amazon.com/toolkit-for-eclipse/v1/user-guide/tke_java_apps.html

Cannot actually compile my java code. Yes really. 5 hours later, I think the PATH environmental variable is wrong
http://www.cs.fsu.edu/~myers/cop3252/howto/cmdline.html
Eventually realised the PATH variable was wrong on my PC for the JDK. Reinstalled java and then updated the PATH variable. CMD can now find the java compiler! Lamest error of all time, but wasted 5 hours on it.

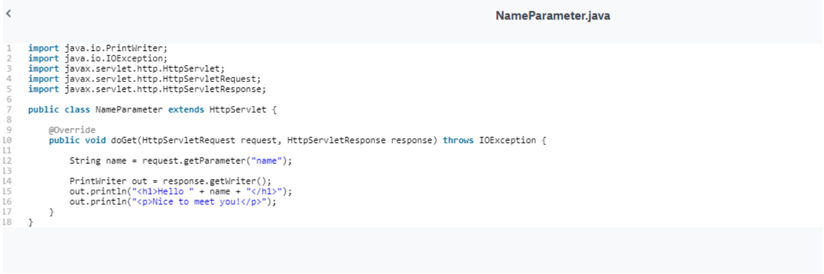
23/02/2020

- Considering data transfer from toybox scanner to server:
  - Format: timestamp, toybox scanner ID, RFID ID
  - Bytes: 20, 20, 100 ? = 140 bytes per toy tag
  - 140 x 100 = 14,000bytes; 14kb
  - Too long for POST (2kb limit)
  - Can work for PUT? Will need to be in JSON format?

23/02/2020

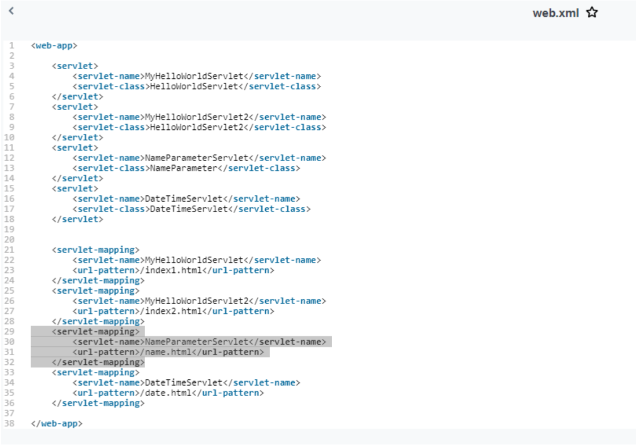
- Fixed compiler - reinstalled jdk and updated path environment variable on my laptop. Incredible waste of time

- Now have functioning local server using jetty. Just using servlets at the moment. Reading through the tutorial, I think I'll need to use jsp pages
- have got it to the point that it accepts input via url and displays it on the page:



NameParameter.java

```java
import java.io.PrintWriter;
import java.io.IOException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

public class NameParameter extends HttpServlet {

    @Override
    public void doGet(HttpServletRequest request, HttpServletResponse response) throws IOException {

        String name = request.getParameter("name");

        PrintWriter out = response.getWriter();
        out.println("<h1>Hello " + name + "</h1>");
        out.println("<p>Nice to meet you!</p>");
    }
}
```

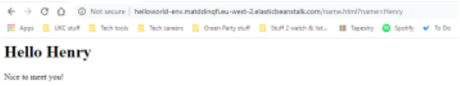


web.xml

```xml
<web-app>

    <servlet>
        <servlet-name>MyHelloWorldServlet</servlet-name>
        <servlet-class>HelloWorldServlet</servlet-class>
    </servlet>
    <servlet>
        <servlet-name>MyHelloWorldServlet2</servlet-name>
        <servlet-class>HelloWorldServlet2</servlet-class>
    </servlet>
    <servlet>
        <servlet-name>NameParameterServlet</servlet-name>
        <servlet-class>NameParameter</servlet-class>
    </servlet>
    <servlet>
        <servlet-name>DateTimeServlet</servlet-name>
        <servlet-class>DateTimeServlet</servlet-class>
    </servlet>


    <servlet-mapping>
        <servlet-name>MyHelloWorldServlet</servlet-name>
        <url-pattern>/index1.html</url-pattern>
    </servlet-mapping>
    <servlet-mapping>
        <servlet-name>MyHelloWorldServlet2</servlet-name>
        <url-pattern>/index2.html</url-pattern>
    </servlet-mapping>
    <servlet-mapping>
        <servlet-name>NameParameterServlet</servlet-name>
        <url-pattern>/name.html</url-pattern>
    </servlet-mapping>
    <servlet-mapping>
        <servlet-name>DateTimeServlet</servlet-name>
        <url-pattern>/date.html</url-pattern>
    </servlet-mapping>

</web-app>
```

24/02/2020

- Basic server now live on AWS: http://helloworld-env.matddingfi.eu-west-2.elasticbeanstalk.com/



Hello Henry

Nice to meet you!

redirect set up for henrystanton.co.uk
Screen clipping taken: 24/02/2020 12:27

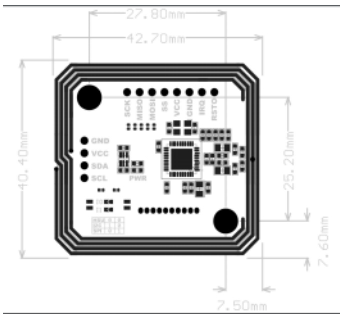
Revision of tasks (priorities for videos highlighted):

Things to do:	
	~~Make components list~~
Scanner	~~Get components together~~
	~~Get scanner to see tags~~ ~~Get scanner connected to wifi~~
	~~Get scanner to feedback on succesful scan - LED or beep~~
Extension	~~Get a box for the scanner to sit in~~
	~~Get scanner to store number of tags with timestamp~~
Extension	Get scanners to act as APs on startup (with reset option)
Extension	Set up web page / form for entering SSID and pasword for wifi
	~~Sort some communication routine for sending data to website - wait for web server to poll or just post info every few seconds?~~
Extension	Sort some sort of loss of connection to web server protocol (If web server or Internet goes down) - ~~file cache save~~
Website	~~Setup web server system (uni host?)~~
	Sort file store for respective toybox scanners
	Create logic for handling state updates and sending commands to sweet box https://en.wikipedia.org/wiki/WebSocket#Overview
	~~Setup/find CSS template / reactive framework~~
Extension	Sort sending data for TFT display
Extension	make account / home web page
Extension	make db for storing account info
Extension	Make web page for registering devices (with naming facility)
Extension	Make web page for registering and deleting toy tags to/from device (with naming facility for toys)
	~~make device status web page (with numbers of toy tags per device and battery status)~~
Extension	make analysis web page - child performance (really toybox performance) / toy performance - with graphs?
Extension	Alert system if unrecognised toytags are in a toybox?
Sweetbox	Get a box
	Get sensor on box
	Get latch on box and latching
Extension	~~Get LED/speaker on toybox scanner~~
	~~Get ESP32 toybox to light up LED/Beep~~
	Get sweetbox ESP32 to actuate latch
	Get sweetbox ESP32 to lock if microswitch shows closed
Extension	~~Get toybox scanner to store UUID and toytag info on SD card for cache purposes~~
Extension	Connect display to sweetbox ESP32
Extension	Get display to show bar chart / web page image of bar chart?

ESP32 case:

- Will need a case for toybox scanner and sweetbox scanner
- Going to use the laser cutter - requires a DXF vector file
- This one is a basic box that fits an ESP32, but without any holes for micro usb leads, batteries or leds or speakers - would work for

esp32_case

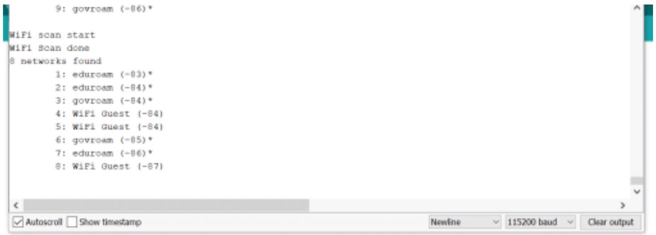


Screen clipping taken: 24/02/2020 18:03

https://www.nxp.com/docs/en/user-guide/141520.pdf
https://www.instructables.com/id/ESP32-With-RFID-Access-Control/ - help with RFID and esp32
https://learn.adafruit.com/adafruit-huzzah32-esp32-feather/using-with-arduino-ide

http://www.elechouse.com/elechouse/images/product/PN532_module_V3/PN532_%20Manual_V3.pdf

- Arduino IDE installed
- Board drivers installled and board selected
- Board connected on COM 5
- 115200 baud is correct rate
- Some sort of WIFI scanning program built in - is showing output on Serial output - will be useful for setting up as Aps during installation process in the future
- ★ Need to get a Lithium Polymer battery



```
        9: govroam (-86)*

WiFi scan start
WiFi Scan done
8 networks found
        1: eduroam (-83)*
        2: eduroam (-84)*
        3: govroam (-84)*
        4: WiFi Guest (-84)
        5: WiFi Guest (-84)
        6: govroam (-85)*
        7: eduroam (-86)*
        8: WiFi Guest (-87)
```

☑ Autoscroll □ Show timestamp — Newline — 115200 baud — Clear output

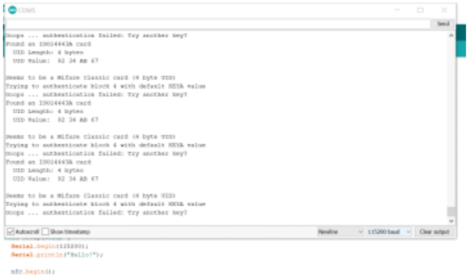
Screen clipping taken: 24/02/2020 17:23

Note that you need the baud rate to be 115200 because we need to print out the data and read from the card at the same time!

Now reading rfid tags (my student card) - using example code from PN532 library (readMifare.ino) with:

- Didn't work initially but then with i2c includes uncommented
- Jumper leads as follows:

PN532	ESP32
VCC	3V
GND	GND
SDA	SDA
SCL	SCL



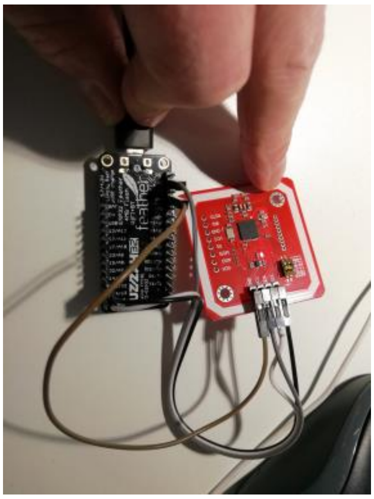
COM5 — Send

```
Ooops ... authentication failed: Try another key?
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67

Seems to be a Mifare Classic card (4 byte UID)
Trying to authenticate block 4 with default KEYA value
Ooops ... authentication failed: Try another key?
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67

Seems to be a Mifare Classic card (4 byte UID)
Trying to authenticate block 4 with default KEYA value
Ooops ... authentication failed: Try another key?
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67

Seems to be a Mifare Classic card (4 byte UID)
Trying to authenticate block 4 with default KEYA value
Ooops ... authentication failed: Try another key?
```

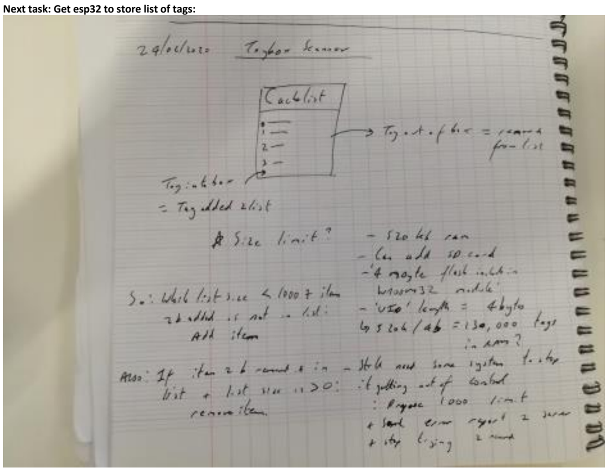
☑ Autoscroll □ Show timestamp — Newline — 115200 baud — Clear output

```
  Serial.begin(115200);
  Serial.println("Hello!");

  nfc.begin();
```

Screen clipping taken: 24/02/2020 19:33



Next task: Get esp32 to store list of tags:



24/02/2020 Toybox Scanner

Cachelist
1 —
2 —
3 —

→ Toy out of box = remove from list

Toy in to box
= Toy added 2 list

Size limit?

- 520 kB ram
- Can add SD card
- '4 megabyte flash included in Wroom32 module'
- 'UID' length = 4 bytes
↳ 520kb / 4b = 130,000 tags in RAM?

So: While list size < 1000 & item 2b added is not in list:
Add item

Also: If item 2b removed & in list & list size is > 0:
remove item

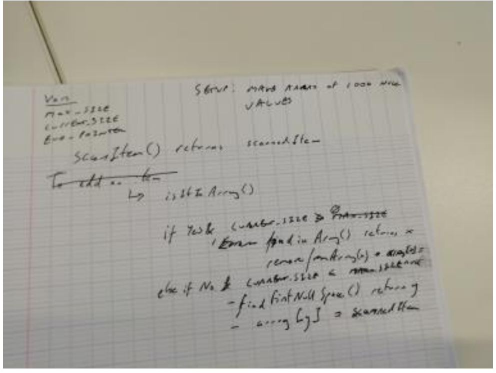
- Still need some system to stop it getting out of control
: Propose 1000 limit
+ Send error report 2 server
+ stop logging 2 [illegible]

- Cos Arduino is shit with collections, having to use an array to store toytags
- This is a problem cos will have to:
  - Iterate over entire thing to check for duplicates/whether item is in box if it needs to be removed
  - If duplicate, no update made
    - Else: iterate through list to find null slot, otherwise will have to shuffle list down each time- total waste of time
  - If removing, need to find item
    - If not in list, need error message?
    - If in list, need to note index and amend to null entry

Measuring battery on ESP32:

- https://learn.adafruit.com/adafruit-feather-32u4-basic-proto/power-management

25/02/2020



Vars
max_size
current_size
Error-parameter

Setup: make array of 1000 null values

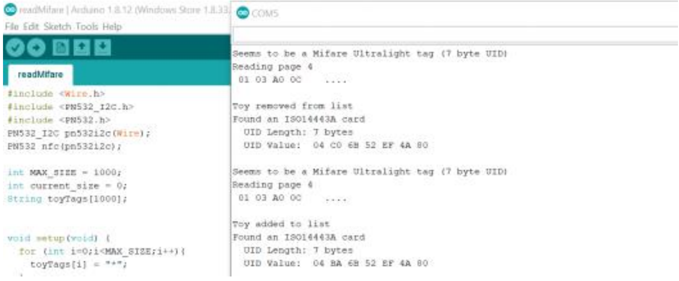
scanItem() returns scannedItem

~~To add an item~~
↳ isItInArray()

if Yes & current_size > ~~max_size~~ 0
~~Error~~ findInArray() returns x
removeFromArray(x) → array[x] =

else if No & current_size < max_size and
- findFirstNullSpace() returns y
- array[y] = scannedItem

Tags added/removed from list (toybox)



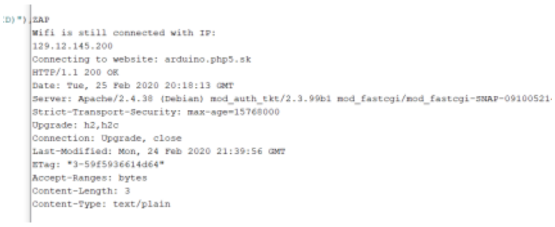
readMifare | Arduino 1.8.12 (Windows Store 1.8.33)
File Edit Sketch Tools Help
readMifare
COM5

```
#include <Wire.h>
#include <PN532_I2C.h>
#include <PN532.h>
PN532_I2C pn532i2c(Wire);
PN532 nfc(pn532i2c);

int MAX_SIZE = 1000;
int current_size = 0;
String toyTags[1000];


void setup(void) {
  for (int i=0;i<MAX_SIZE;i++){
    toyTags[i] = "*";
```

```
Seems to be a Mifare Ultralight tag (7 byte UID)
Reading page 4
 01 03 A0 0C    ....

Toy removed from list
Found an ISO14443A card
  UID Length: 7 bytes
  UID Value:  04 C0 6B 52 EF 4A 80

Seems to be a Mifare Ultralight tag (7 byte UID)
Reading page 4
 01 03 A0 0C    ....

Toy added to list
Found an ISO14443A card
  UID Length: 7 bytes
  UID Value:  04 BA 6B 52 EF 4A 80
```

Screen clipping taken: 25/02/2020 15:48

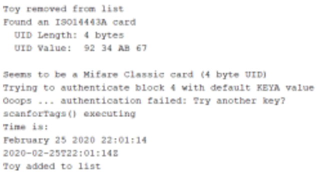
Get scanner connected to wifi



```
:D)"); ZAP
Wifi is still connected with IP:
129.12.145.200
Connecting to website: arduino.php5.sk
HTTP/1.1 200 OK
Date: Tue, 25 Feb 2020 20:18:13 GMT
Server: Apache/2.4.38 (Debian) mod_auth_tkt/2.3.99b1 mod_fastcgi/mod_fastcgi-SNAP-09100521·
Strict-Transport-Security: max-age=15768000
Upgrade: h2,h2c
Connection: Upgrade, close
Last-Modified: Mon, 24 Feb 2020 21:39:56 GMT
ETag: "3-59f5936614d64"
Accept-Ranges: bytes
Content-Length: 3
Content-Type: text/plain
```

Screen clipping taken: 25/02/2020 20:18

Get scanner to store number of tags with timestamp
https://randomnerdtutorials.com/esp32-ntp-client-date-time-arduino-ide/
Timestamp sorted



```
Toy removed from list
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67

Seems to be a Mifare Classic card (4 byte UID)
Trying to authenticate block 4 with default KEYA value
Ooops ... authentication failed: Try another key?
scanforTags() executing
Time is:
February 25 2020 22:01:14
2020-02-25T22:01:14Z
Toy added to list
```

Screen clipping taken: 25/02/2020 22:01

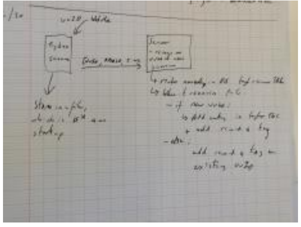
Problems encountered: Adjustment to GMT time

26/02/2020

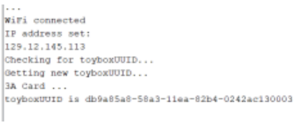
⭐ **NB Check all connections - malfunction this morning was due to very slight looseness**

Now need to store it with toy tagID and toybox id (so that if a toy is in wrong box, server can send notification to webpage)

? Where will toyboxIDs come from - allocated by server or UUIDs? From https://www.uuidgenerator.net/api

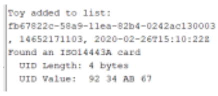


Conclusion: UUID generated on first connection to Internet and then stored in SD card file



```
...
WiFi connected
IP address set:
129.12.145.113
Checking for toyboxUUID...
Getting new toyboxUUID...
3A Card ...
toyboxUUID is db9a85a8-58a3-11ea-82b4-0242ac130003
```

Store tags in 2d array in format - {toybox scanner UUID; toytagID; timestamp}
https://forum.arduino.cc/index.php?topic=220385.0 - 2d arrays



```
Toy added to list:
fb67822c-58a9-11ea-82b4-0242ac130003
, 14652171103, 2020-02-26T15:10:22Z
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67
```

Screen clipping taken: 26/02/2020 15:11

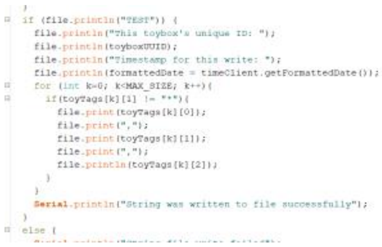
Get scanner to store list in a file - to do this, will need >512b, so cannot store in EEPROM and will therefore need to store on SD card. This is required for two reasons:

a. To store the UUID of the toybox in the event of loss of power e.g. battery runs out
b. To store cache of current toybox list (in the event of loss of internet/power)
    i. However, in the event that power loss happens, if children add or remove toys in the time the system is down, confusion is unavoidable and essentially, system will need resetting and toybox emptying
    ii. If internet goes down, cache will ensure that system can continue to operate until contact with server is reestablished

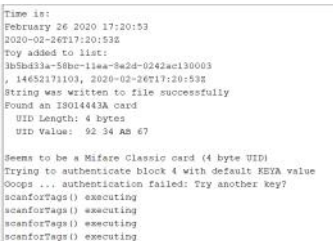
http://www.iotsharing.com/2017/05/how-to-use-arduino-esp32-to-store-data-to-sdcard.html
https://techtutorialsx.com/2018/08/05/esp32-arduino-spiffs-writing-a-file/

? How often to write to file?

- After each scan? Seems intensive - bearing in mind current list will need writing (at least, those entries with data in)
- However, in case of unsafe shutdown (e.g. sudden loss of power), need to ensure that any file write has ended and file been closed. If file is left open, could be a problem for the file in the event of power loss
- Also, timed writing (e.g. every loop, or every 5 mins) or entire file seems unnecessarily processor intensive when a toy may only be taken out every 5 minutes or, during tidy up lots of toys may be placed in box in 5 mins but then no activity for hours after that
- So, short of having a buffer, I will go with writing whole list to file after each scan



```
  }
  if (file.println("TEST")) {
    file.println("This toybox's unique ID: ");
    file.println(toyboxUUID);
    file.println("Timestamp for this write: ");
    file.println(formattedDate = timeClient.getFormattedDate());
    for (int k=0; k<MAX_SIZE; k++){
      if(toyTags[k][1] != "*"){
        file.print(toyTags[k][0]);
        file.print(",");
        file.print(toyTags[k][1]);
        file.print(",");
        file.println(toyTags[k][2]);
      }
    }
    Serial.println("String was written to file successfully");
  }
  else {
```



```
Time is:
February 26 2020 17:20:53
2020-02-26T17:20:53Z
Toy added to list:
3b5bd33a-58bc-11ea-8e2d-0242ac130003
, 14652171103, 2020-02-26T17:20:53Z
String was written to file successfully
Found an ISO14443A card
  UID Length: 4 bytes
  UID Value:  92 34 AB 67

Seems to be a Mifare Classic card (4 byte UID)
Trying to authenticate block 4 with default KEYA value
Ooops ... authentication failed: Try another key?
scanforTags() executing
scanforTags() executing
scanforTags() executing
scanforTags() executing
```

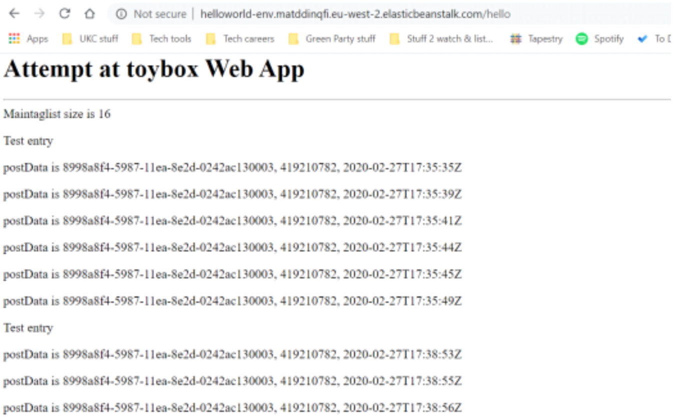
27/02/2020
https://techtutorialsx.com/2017/05/20/esp32-http-post-requests/
https://happycoding.io/tutorials/java-server/post#post-requests

~~make device status web page (with numbers of toy tags per device and~~

~~Sort some communication routine for sending data to website - wait for web server to poll or just post info every few seconds?~~

- Max poss size of list is: (3b5bd33a-58bc-11ea-8e2d-0242ac130003, 14652171103, 2020-02-26T17:27:36Z) * 1000 = 69*1000 = 69000b = 69kb

Website displays data posted from ESP32 (UUID of toybox scanner, RFID ID, Timestamp of scan:



Attempt at toybox Web App

Maintaglist size is 16

Test entry

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:35Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:39Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:41Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:44Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:45Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:49Z

Test entry

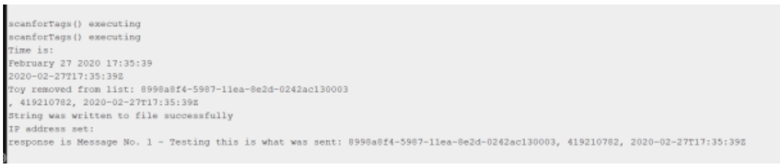
postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:38:53Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:38:55Z

postData is 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:38:56Z

Screen clipping taken: 27/02/2020 18:50 http://helloworld-env.matddinqfi.eu-west-2.elasticbeanstalk.com/hello

At client (ESP32) end:

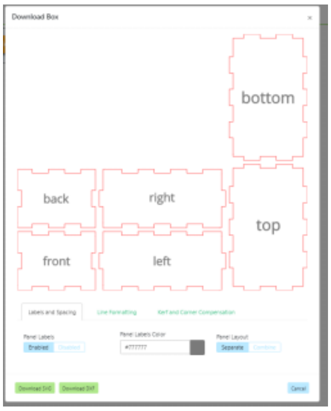


```
scanforTags() executing
scanforTags() executing
Time is:
February 27 2020 17:35:39
2020-02-27T17:35:39Z
Toy removed from list: 8998a8f4-5987-11ea-8e2d-0242ac130003
, 419210782, 2020-02-27T17:35:39Z
String was written to file successfully
IP address set:
response is Message No. 1 - Testing this is what was sent: 8998a8f4-5987-11ea-8e2d-0242ac130003, 419210782, 2020-02-27T17:35:39Z
```

Screen clipping taken: 27/02/2020 18:53

- ~~Need to update some data in a file on server e.g. each time there's a scan event, need to send msg to server w record for tha t scan event so that server updates file~~
- https://happycoding.io/tutorials/java-server/post#post-requests
- User needs to see:
  - What toybox
  - Has what toys - will require same logic as on esp32 to maintain up to date list
  - At what time
-
- Separately need a JSP/servlet that will display whatever is in that file when the web client requests it - needs to be a bit more user friendly
-
- Need to make the page reactive using Bootstrap so that it shrinks to the right size

~~Make case for toybox scanner~~



Panel Labels: Enabled / Disabled

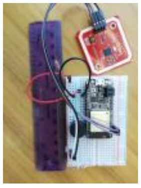
Panel Labels Color: #777777

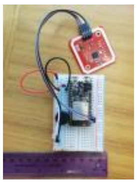
Panel Layout: Separate / Combine

Screen clipping taken: 27/02/2020 19:42

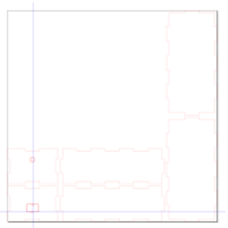
28/02/2020

- ESP32 down middle - each row gives you access to the relevant gpio pin (can be digital or pwm)
- Buzzer will need 1 ground and 1 pwm pin
- Gnd and 3v go into the +ve and -ve columns down the side
- Need to re-do case to reflect extra depth of bread board





-



Screen clipping taken: 28/02/2020 11:19

- ~~Led - flat side to ground. Doesn't matter where resistor goes. - LED will need 2 x cables soldering to it to go into breadboard~~
- ~~Breadboard questions:~~
  - ~~Can I put jumpers from the row of one pin across to a random row that doesn't have any pins on it and then connect e.g. the LED or buzzer to it?~~
    - ~~Will need 1 x M-M jumper for buzzer to go to GPIO 12 for buzzer~~
    - ~~Will need 2 x cables soldered to LED to go into GPIO A5? For LED~~
  - ~~OR:~~
  - ~~Can I put jumpers from one side bar across to the other sidebar?~~
- ~~Need to get case printed~~
- ~~Need to do some instructions for server and scanner~~

~~Get LED/speaker on toybox scanner - https://www.instructables.com/id/Blinking-an-LED-With-ESP32/ https://techtutorialsx.com/2017/07/01/esp32-arduino-controlling-a-buzzer-with-pwm/~~

01/03/2020

- LED and buzzer now working with scanner
- Had to change wifi code to work for home network instead of enterprise network
- ★ Live test using an actual toy (plastic duck), shows tat range of scanner is <10mm - sticker tag needs to be face down to scanner device - will not scan if duck is upside down - could be a problem for kids

03/03/2020

- ~~Need to sort AJAX response on website -~~ painful cos of servlets being interfaces and not allowing storing of collections
- ~~Website needs to show % of toys returned - need to have separate list of toys that are registered to the toybox~~
-
- ★ ~~Li poly battery is required with jst connector, 3.7v~~ ordered

? ~~Case with holes in? - Make simple case plan using makecase.com, download as svg then amend with holes in on inkscape. Use 'fingering' to make stron ger case; glue with superglue~~

Issues revealed:

- RFID stickers stick well to plastic/wood, not to fluffy stuff
- Also not good at sticking to curved surfaces
- Also, will not work if stuck over battery compartments - annoyingly these are often the only flat parts of a toy!
- Need to be stuck to some part of toy that is possible to make contact with scanning device. Wouldn't work if contact could not be made
- System is a bit laggy - kids want to scan quicker than system can handle - wouldn't always respond as a result. OK for 4 yr old, not for 2 yr old

Ongoing requirements:

★ Need to incorporate jitter - small bit of randomness into comms to server to avoid accidental sync with other toybox scanner devices

★ Need an acknowledgement to be sent back if transmission successful/unsuccessful so that toybox scanner can handle the consequ ence - needs to re-post updated list when contact with server is re-establishe

★ Need to add in battery

★ Website needs to show battery status at some point

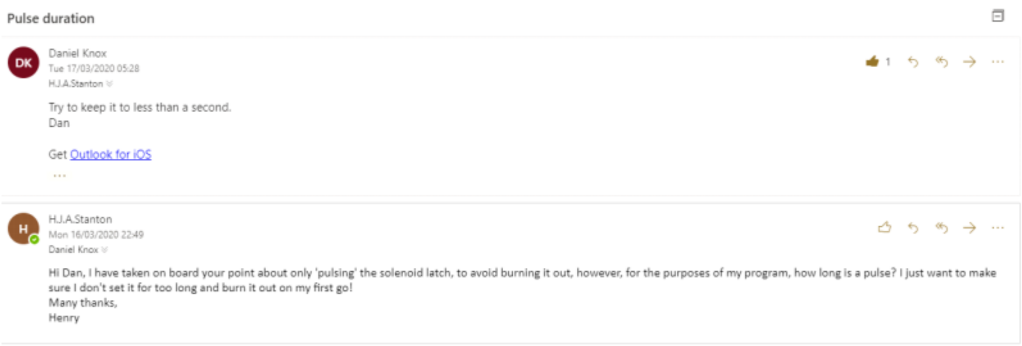
★ Need to figure out how to get a permanent file stored on server

Ideal requirements for system at end:

- Multiple devices
- Data gathering and analysis
- Visualisation - https://vidabox.com/blog/2017/02/11/hidden-always-on-setting-for-amazon-fire-tablets/

16/03/2020

- **For sweet box:**
  - Bread board
  - 12v adaptor
  - 2 x LEDs and 2 x 220 resistors
  - Bridge
  - Solenoid latch
- 12v adaptor goes into 12v hole and GND hole on bridge board
- Latch neg and pos wires go into left or right side output of bridge board
- ESP32 goes into breadboard
- ★ Bridge board has 4 x input pins to connect to ESP32 GPIO pins - I think they operate as a truth table - 00 or 11 mean nothing happens;10 will turn on or off and 01 will do the opposite. Will need to look this up
- I *think* the bridge board also needs a shared ground with the esp32. As in, pos input covered by the 4x input pubs and then bridge board needs a GND so will need jumper from Bridge board GND (socket shared with PSU GND) to bread board GND. PSU GND m ust only go to bridge board, NOT via breadboard
- 2 x leds will need a 220 resistor each and a gpio and GND connection
- The latch should only be pulsed on and off - long pulse will quickly burn it out - how long is a pulse?



Pulse duration

Daniel Knox
Tue 17/03/2020 05:28
H.J.A.Stanton

Try to keep it to less than a second.
Dan

Get Outlook for iOS

H.J.A.Stanton
Mon 16/03/2020 22:49
Daniel Knox

Hi Dan, I have taken on board your point about only 'pulsing' the solenoid latch, to avoid burning it out, however, for the purposes of my program, how long is a pulse? I just want to make sure I don't set it for too long and burn it out on my first go!
Many thanks,
Henry

Screen clipping taken: 17/03/2020 12:55

17/03/2020

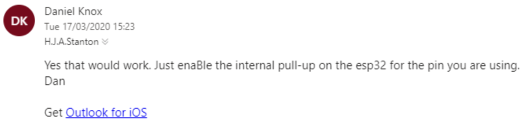
Things to do (note clear delineation of extension tasks - not all of this will be possible in time available):

Things to do:	
Scanner	
Extension	Get scanners to act as APs on startup (with reset option)
Extension	Set up web page / form for entering SSID and pasword for wifi
Extension	Sort some sort of loss of connection to web server protocol (If web server or Internet goes down)
Website	Create logic for handling state updates and sending commands to sweet box
Extension	Sort sending data for TFT display
Extension	make account / home web page
Extension	make db for storing account info
Extension	Make web page for registering devices (with naming facility)
Extension	Make web page for registering and deleting toy tags to/from device (with naming facility for toys)
Extension	make analysis web page - child performance (really toybox performance) / toy performance - with graphs?
Extension	Alert system if unrecognised toytags are in a toybox?
Extension	Get display to show bar chart / web page image of bar chart?
Sweetbox	Get a box
	Get sensor on box
	Get latch on box and latching
Extension	Get LED/speaker on box
	Connect above to ESP32
	Get ESP32 to actuate latch

	Get ESP32 to light up LED/Beep
	Get ESP32 to lock if switch closed

Microswitch:

Screen clipping taken: 17/03/2020 16:11

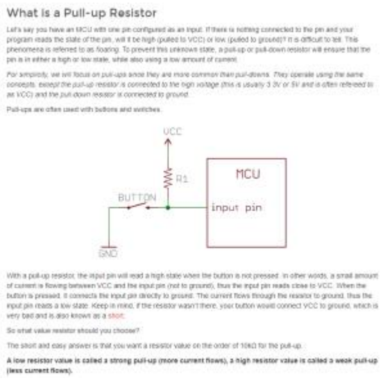


Daniel Knox
Tue 17/03/2020 15:23
H.J.A.Stanton

Yes that would work. Just enaBle the internal pull-up on the esp32 for the pin you are using.
Dan

Get [Outlook for iOS]

Screen clipping taken: 17/03/2020 16:11



What is a Pull-up Resistor

Let's say you have an MCU with one pin configured as an input. If there is nothing connected to the pin and your program reads the state of the pin, will it be high (pulled to VCC) or low (pulled to ground)? It is difficult to tell. This phenomena is referred to as *floating*. To prevent this unknown state, a pull-up or pull-down resistor will ensure that the pin is in either a high or low state, while also using a low amount of current.

For simplicity, we will focus on pull-ups since they are more common than pull-downs. They operate using the same concepts, except the pull-up resistor is connected to the high voltage (this is usually 3.3V or 5V and is often refereed to as VCC) and the pull-down resistor is connected to ground.

Pull-ups are often used with buttons and switches.

With a pull-up resistor, the input pin will read a high state when the button is not pressed. In other words, a small amount of current is flowing between VCC and the input pin (not to ground), thus the input pin reads close to VCC. When the button is pressed, it connects the input pin directly to ground. The current flows through the resistor to ground, thus the input pin reads a low state. Keep in mind, if the resistor wasn't there, your button would connect VCC to ground, which is very bad and is also known as a short.

So what value resistor should you choose?

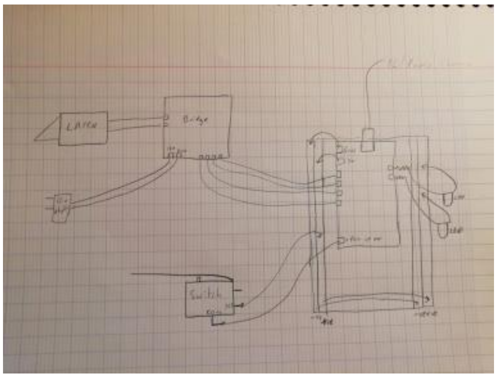
The short and easy answer is that you want a resistor value on the order of 10kΩ for the pull-up.

A low resistor value is called a strong pull-up (more current flows), a high resistor value is called a weak pull-up (less current flows).

Screen clipping taken: 17/03/2020 16:12

22/03/2020
Sweetbox device:

-



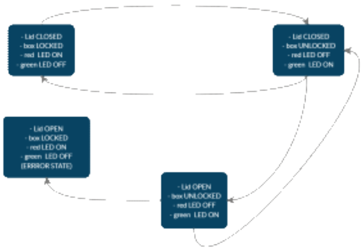
-

23/03/2020
Limit switches:
https://www.youtube.com/watch?v=pf_Mngbx32w
https://www.youtube.com/watch?v=6wuInF9Yw08

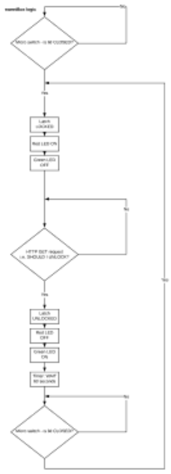
- Need to get latch working to check it does operate like a bolt (one pulse to unlock, another pulse to lock)
    - So will hook device up to wifi and put a button on server page that responds to device http request, so that we can test how the latch works
- Also, need to test switch - Never Open or Never Close mode. I think I've got it the right way round. Need it to update boolean variable regarding box opened or box closed status
    - If box has been unlocked and opened, switch will update boolean var to indicate current state
    - Then if box closed
- LEDs:
    - Red LED indicates to kids box is locked
    - Green LED indicates to kid that box is unlocked

State diagram for sweetBox:

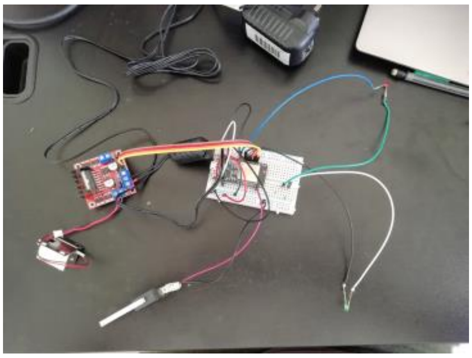
-

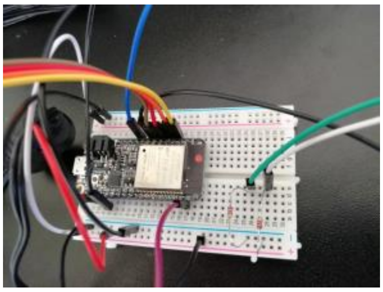


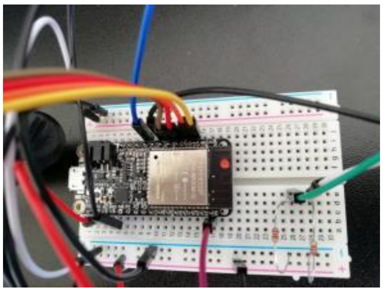
[illegible]

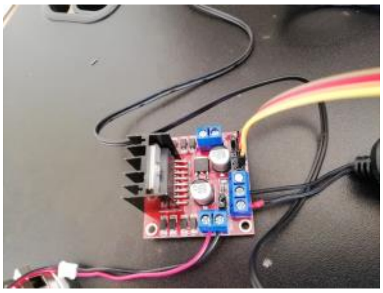


The sweetBox physical system:









Physical Box

- Due to Corona, can't now make one in the shed by laser cutting wood
- So am working with my dad to make one
- Current plan is to cut down this old box we found lying around in his workshop:

-

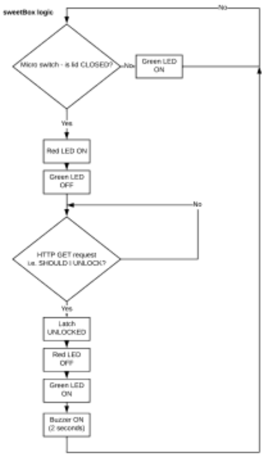
What if Internet goes down?

- **For sweetBox device, assuming it sends a request asking whether to open:**
    - If box lid CLOSED and latch LOCKED: Stays locked
    - If box lid CLOSED and latch UNLOCKED: Times out and goes to LOCKED or lid is opened in which case:
    - If box lid OPEN and latch UNLOCKED: Stays unlocked until lid is CLOSED, at which point it goes to LOCKED
- **For server:**
    - Needs to know what time the request was sent? So as to respond in a timely fashion or not at all?

Want to put a buzzer in to the sweetbox as well

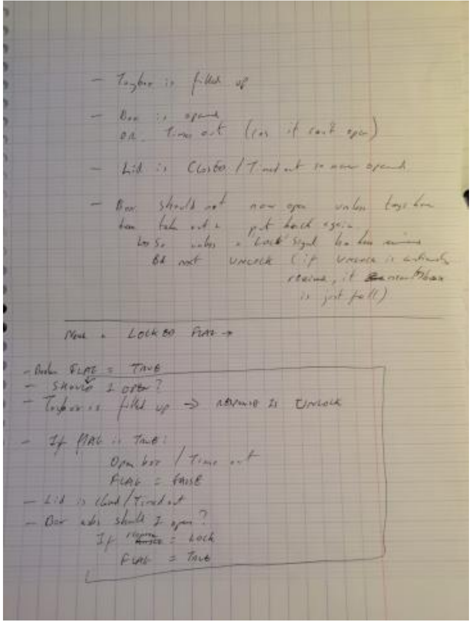
https://www.amazon.co.uk/Adafruit-160-Piezo-Buzzer-ADA160/dp/B01BNNNYB4/ref=sr_1_5?dchild=1&keywords=Adafruit+Piezo+Buzzer&qid=1585143327&refinements=p_76%3A419158031&rnid=419157031&rps=1&sr=8-5

01/04/2020

- Now got latch working. Due to requirement to not pulse for >1 second, the box will not work as intended
- So now need to have a spring-loaded box with latch pulsing once to open box and then will require user (parent or child) to close box afterwards. Clearly not ideal - what child will actually close a sweetbox?!
- So new system will need to work as follows:
- 

- So need to get myself a spring

PROBLEM 1: What if something has been put on box? It will keep trying to open - need a timeout
PROBLEM 2: When lid is closed again, needs to know that it should not reopen until toys have been taken out



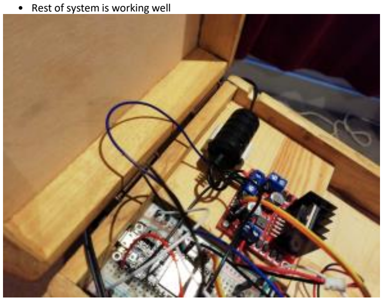
- Toybox is filled up
- Box is opened
  OR time out (cos it can't open)
- Lid is Closed / Timed out so never opened
- Box should not now open unless toys have been taken out & put back again
  So unless a 'Lock' signal has been received
  Do not UNLOCK (if Unlock is actually received, it means box is just full)

Need a Lock box FLAG →

- Boolean FLAG = TRUE
- Should I open?
- Toybox is filled up → assume is Unlock
- If FLAG is TRUE:
  Open box / Time out
  FLAG = FALSE
- Lid is closed / Timed out
- Box asks should I open?
  If response = Lock
  FLAG = TRUE

06/04/2020

- Box Development:
    - Major problems with getting latch/hook interface to work
    - Latch is essentially quite crap - too much upward pressure on it stops it working
    - So I have cut down the spring to reduce the pressure. Seemingly, any upward pressure to close to the casing will stop it wor king though
    - Have now shorted the bridge while trying to adjust the latch. I think it was the metal wristband of my watch
    - ESP32 still works and latch still works so have ordered a new bridge
    - Rest of system is working well



12/04/2020

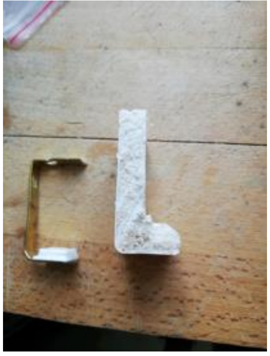
New bridge has arrived so system working again.

Still working on the latch - sodding latch just cannot take any upward pressure - just will not work. Driving me up the bloody wall

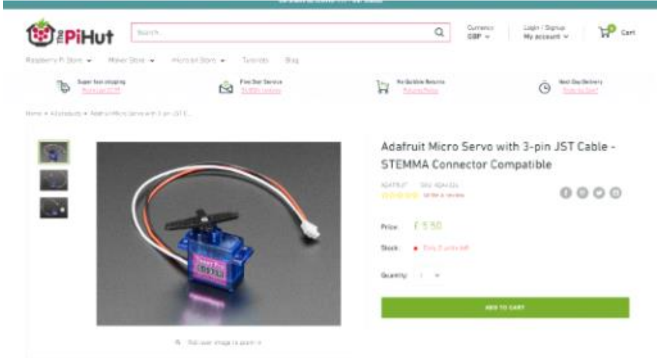
Options:

- Put a push button on the exterior - kids can unlock box **if green light is showing** by pressing the push button (overcomes the problem of burning the latch out if the latch is held in a HIGH state for >1 sec)
- See if it does actually burn out if held for >1 sec
- Change for a latch that can work with upward pressure
- Change for some sort of bolt mechanism that can move between two positions
- Don't use a latch and instead use a servo motor that rotates a hook around into a loop - would get rid of the need for a spring entirely:
- https://thepihut.com/products/adafruit-micro-servo-with-3-pin-jst-cable-stemma-connector-compatible-ada4326

One option I've tried is to amend the profile of the hook, to try to reduce the upward force, but it hasn't helped (hook on left was 1st attempt, hook on right was 2nd attempt):



Ordered this servo motor to create a hook and eye system like this one:



Adafruit Micro Servo with 3-pin JST Cable - STEMMA Connector Compatible

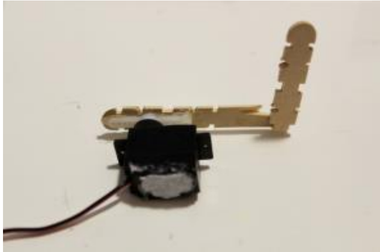
Price: £ 5.50

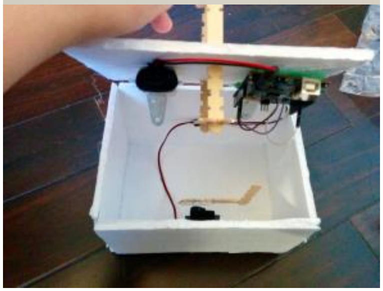
Stock:

Quantity: 1

NB. This motor shouldn't need a driver/bridge/shield. *Should* be ok to run straight off board using PWM.

It should work something like this box (from https://www.instructables.com/id/Private-Lock-Box-With-Pin-Code-Bluetooth-Activated/):

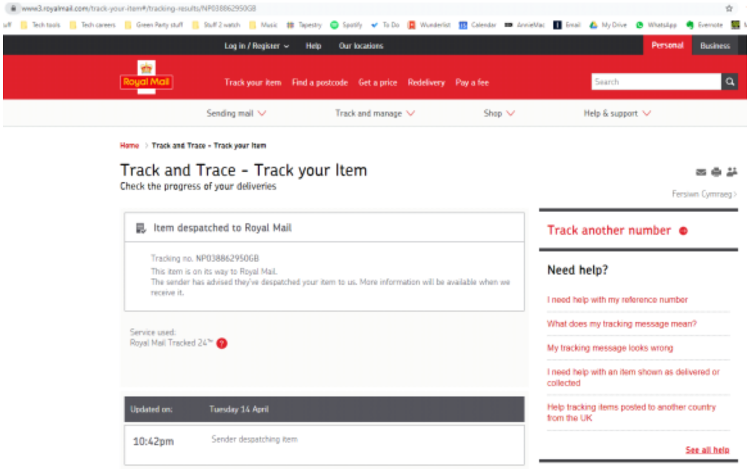




- So I will get rid of the spring and put an eyelet of some kind on the underside of the box lid. Hook attached to motor will t hen rotate into place when lid sensor says box is closed and logic says box should be locked.
- ESP32 will continue to ask server if it should unlock. If yes, motor rotates hook out of eyelet and red LED goes off, green L ED goes on and buzzer sounds.
- Once lid has been opened and then closed again (and more than ~10 seconds has elapsed), motor rotates to locked position and red LED goes on, green LED goes off.
- No need for spring this way.

16/04/2020

Paid extra for next day delivery but bloody motor has not arrived.



Track and Trace - Track your Item

Check the progress of your deliveries

Item despatched to Royal Mail

Tracking no. NP038862950GB

This item is on its way to Royal Mail.

The sender has advised they've despatched your item to us. More information will be available when we receive it.

Service used:
Royal Mail Tracked 24™

Updated on: Tuesday 14 April

10:42pm Sender despatching item

Track another number

Need help?

I need help with my reference number

What does my tracking message mean?

My tracking message looks wrong

I need help with an item shown as delivered or collected

Help tracking items posted to another country from the UK

See all help

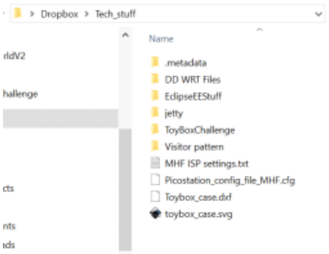
17/04/2020

- Motor has not arrived so will demo latch working, with lid open

UKC Library book RFID chips - a lot bigger than the ones I'm using:

Appendix:

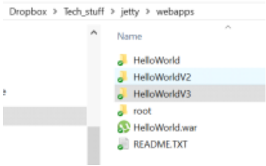
- **Instructions for programming:**
  Everything is stored here (jetty for the server, ToyBoxChallenge for the scanner files):



.metadata
DD WRT Files
EclipseEEStuff
jetty
ToyBoxChallenge
Visitor pattern
MHF ISP settings.txt
Picostation_config_file_MHF.cfg
Toybox_case.dxf
toybox_case.svg

Screen clipping taken: 27/02/2020 20:09

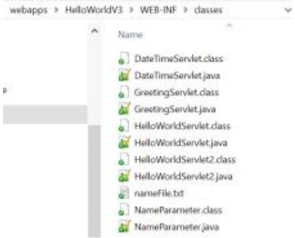
To make changes to server go to latest version of HelloWorld:



HelloWorld
HelloWorldV2
HelloWorldV3
root
HelloWorld.war
README.TXT

Screen clipping taken: 27/02/2020 20:10

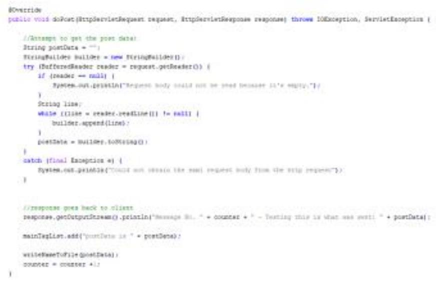
Then go to the java files in the classes folder:



DateTimeServlet.class
DateTimeServlet.java
GreetingServlet.class
GreetingServlet.java
HelloWorldServlet.class
HelloWorldServlet.java
HelloWorldServlet2.class
HelloWorldServlet2.java
nameFile.txt
NameParameter.class
NameParameter.java

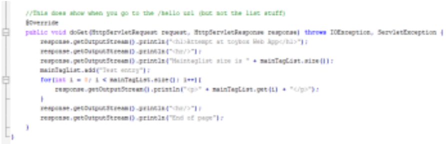
Screen clipping taken: 27/02/2020 20:10

GreetingServlet.java is where the magic happens:
doPost() deals with data coming from toybox scanner (client:



```
@Override
public void doPost(HttpServletRequest request, HttpServletResponse response) throws IOException, ServletException {

    //Attempt to get the post data:
    String postData = "";
    StringBuilder builder = new StringBuilder();
    try (BufferedReader reader = request.getReader()) {
        if (reader == null) {
            System.out.println("Request body could not be read because it's empty.");
        }
        String line;
        while ((line = reader.readLine()) != null) {
            builder.append(line);
        }
        postData = builder.toString();
    }
    catch (final Exception e) {
        System.out.println("Could not obtain the saml request body from the http request");
    }


    //response goes back to client
    response.getOutputStream().println("Message No. " + counter + " - Testing this is what was sent: " + postData);

    mainTagList.add("postData is " + postData);

    writeNameToFile(postData);
    counter = counter +1;
}
```

doGet() displays stuff on a website when a browser visits http://helloworld-env.matddinqfi.eu-west-2.elasticbeanstalk.com/hello



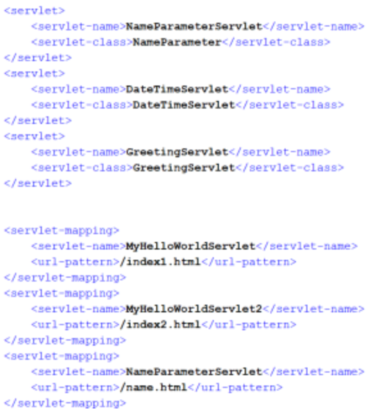
```
    //This does show when you go to the /hello url (but not the list stuff)
    @Override
    public void doGet(HttpServletRequest request, HttpServletResponse response) throws IOException, ServletException {
        response.getOutputStream().println("<h1>Attempt at toybox Web App</h1>");
        response.getOutputStream().println("<hr/>");
        response.getOutputStream().println("Maintaglist size is " + mainTagList.size());
        mainTagList.add("Test entry");
        for(int i = 0; i < mainTagList.size(); i++){
            response.getOutputStream().println("<p>" + mainTagList.get(i) + "</p>");
        }
        response.getOutputStream().println("<hr/>");
        response.getOutputStream().println("End of page");
    }
}
```

Screen clipping taken: 27/02/2020 20:12

As things stand at this time, the 'writeNameToFile()' method does not throw an error, but I've no idea how to access the file, or even if it exists

To get all this onto the server:

- **Firstly compile the servlets that you've made using cmd line, once you're in the folder where the files are stored. Use this line:**
  javac -cp C:\Users\henry\Dropbox\Tech_stuff\CO838_IoT_Toybox_Challenge\Toybox_jetty_server_files\lib\servlet-api-3.1.jar GreetingServlet2.java
- Where the address is the absolute address of where that servlet is stored
  From <https://happycoding.io/tutorials/java-server/servlets>
- Do this for any servlets that you need to use
- Then update the 'mapping' of the xml file:



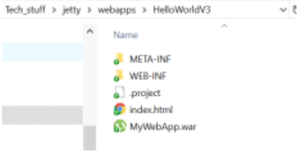
```
<servlet>
    <servlet-name>NameParameterServlet</servlet-name>
    <servlet-class>NameParameter</servlet-class>
</servlet>
<servlet>
    <servlet-name>DateTimeServlet</servlet-name>
    <servlet-class>DateTimeServlet</servlet-class>
</servlet>
<servlet>
    <servlet-name>GreetingServlet</servlet-name>
    <servlet-class>GreetingServlet</servlet-class>
</servlet>



<servlet-mapping>
    <servlet-name>MyHelloWorldServlet</servlet-name>
    <url-pattern>/index1.html</url-pattern>
</servlet-mapping>
<servlet-mapping>
    <servlet-name>MyHelloWorldServlet2</servlet-name>
    <url-pattern>/index2.html</url-pattern>
</servlet-mapping>
<servlet-mapping>
    <servlet-name>NameParameterServlet</servlet-name>
    <url-pattern>/name.html</url-pattern>
</servlet-mapping>
```

Screen clipping taken: 27/02/2020 20:22

Screen clipping taken: 27/02/2020 20:25

- All servlets need both a <servlet> declaration (name and class) and also a 'servlet -mapping' declaration (name and url that will trigger the servlet)

- Then you need to turn the whole lot into a .war file:
  - In cmd line, go to folder where current version of your web app is stored



Tech_stuff > jetty > webapps > HelloWorldV3

Name

META-INF

WEB-INF

.project

index.html

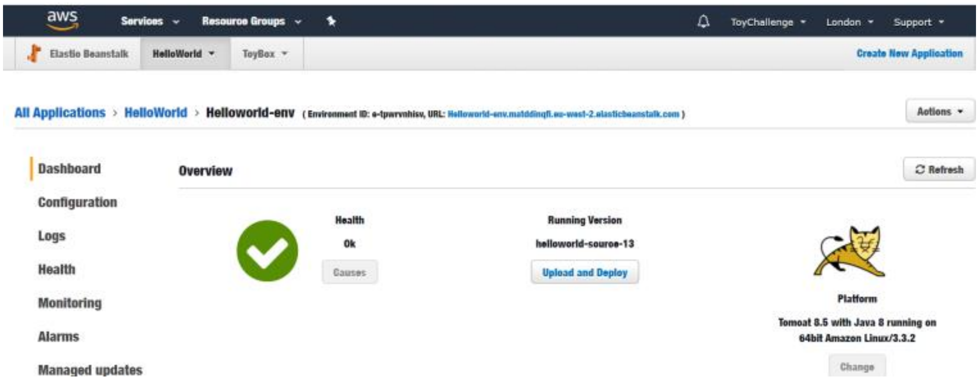
MyWebApp.war

  - Then run this line to create a .war file in this folder: **jar cf MyWebApp.war ***
- Then go to the Amazon dashboard: https://eu-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=eu-west-2#/environment/dashboard?applicationName=HelloWorld&environmentId=e-tpwrvnhisv

AWS Login deets:

- I have accidentally set up 3 accounts
- Correct one is:
  - User: mail@henrystanton.co.uk -
  - Pswd: In chrome, 3 options will come up, it's the straightforward mail@henrystanton.co.uk option. Actual password is unknown but probs usual B0… or hor… one

- Specifically, you're looking for the Elastic Beanstalk service and the HelloWorld -env environment
  - Once there, choose to 'Upload and deploy' the latest .war file:



All Applications > HelloWorld > Helloworld-env (Environment ID: e-tpwrvnhisv, URL: Helloworld-env.matddingfi.eu-west-2.elasticbeanstalk.com)

Overview

Health: Ok

Running Version: helloworld-source-13

Platform: Tomcat 8.5 with Java 8 running on 64bit Amazon Linux/3.3.2

Screen clipping taken: 27/02/2020 20:28

- Server will then be live and the magic happens here:
  - http://helloworld-env.matddingfi.eu-west-2.elasticbeanstalk.com/toys.html
- Other pages are here:
  - http://helloworld-env.matddingfi.eu-west-2.elasticbeanstalk.com/hello)
- To run the server locally, in CMD line, navigate to jetty root directory
  - Then enter **java -jar start.jar**
  - Then browse to http://localhost:8080/HelloWorld/hello

To make changes to toybox scanner device:

- Open latest version of readMifare.ino file in Arduino IDE
- Broadly this divides into 4 parts:
  - Includes and global variable declarations
  - Setup code
  - Mainloop code
  - Function code for the above
- Once adjustments have been made:
  - Plug in the scanner device to PC
  - on the IDE, choose to 'Upload'
  - Check the COM port under Tools
  - Open the serial port (should automatically open for correct COM port)
  - Test by chucking some tags at scanner

Budget created - $10 a month - if it goes up to 80% of this, I will be alerted