

# **CREATING A REAL-LIFE CREATUREPOD**



# Wild Kratts

- Two real-life brothers going on adventures
- Turn into cartoon characters
- Gain creature powers
- Save animals
- Stop bad guys



Inspiration



Inspiration



# Inspiration



# Fun for the Whole Family

- Create something that had never existed before
- Work (play) together as a family
- Experience the fun and challenges of engineering
  - Let kids participate as they wanted to

# Requirements

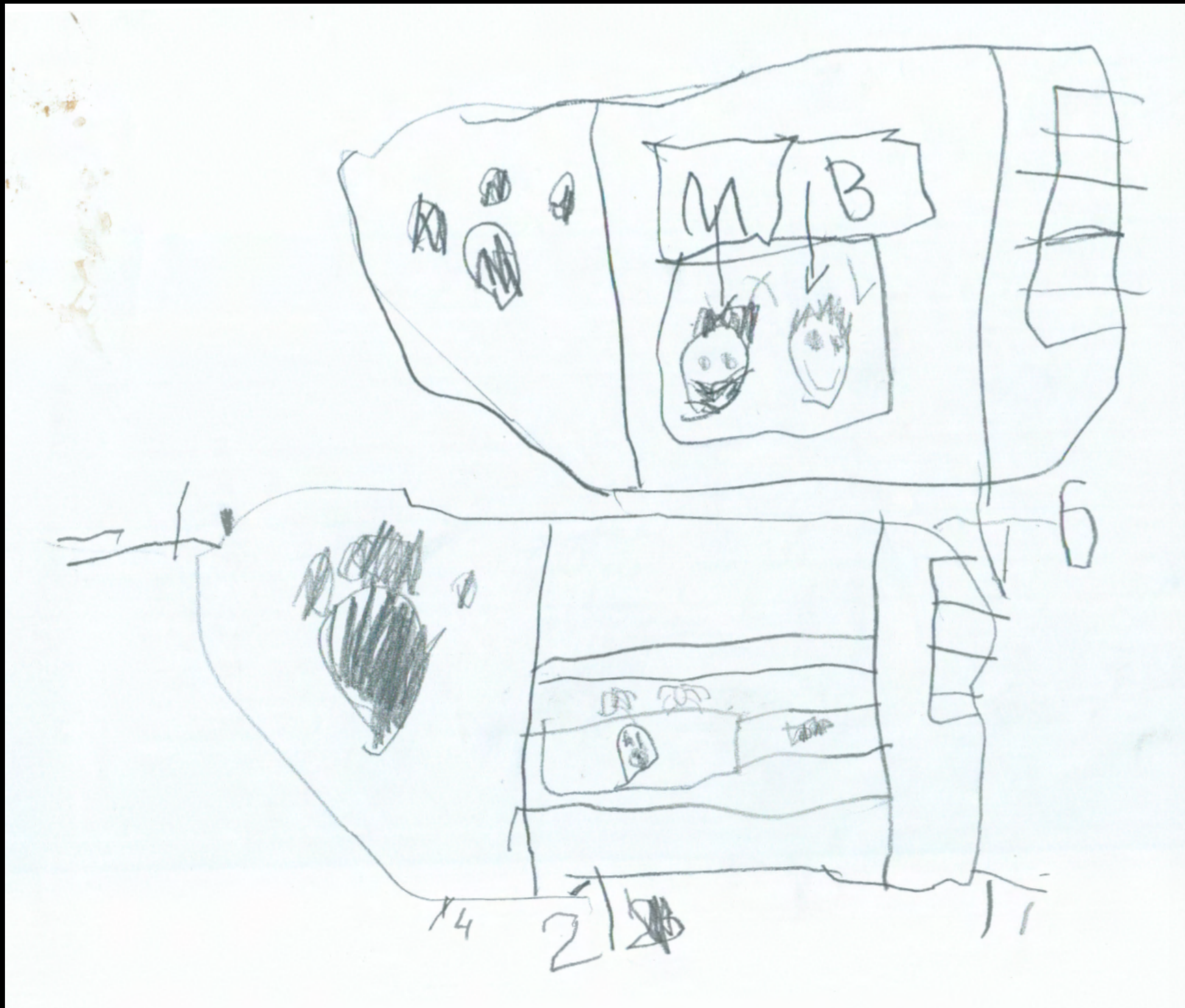
- Look like the fictional Creaturepod
- Allow voice communication like a walkie talkie
- Show picture of the person on the other end

# Process

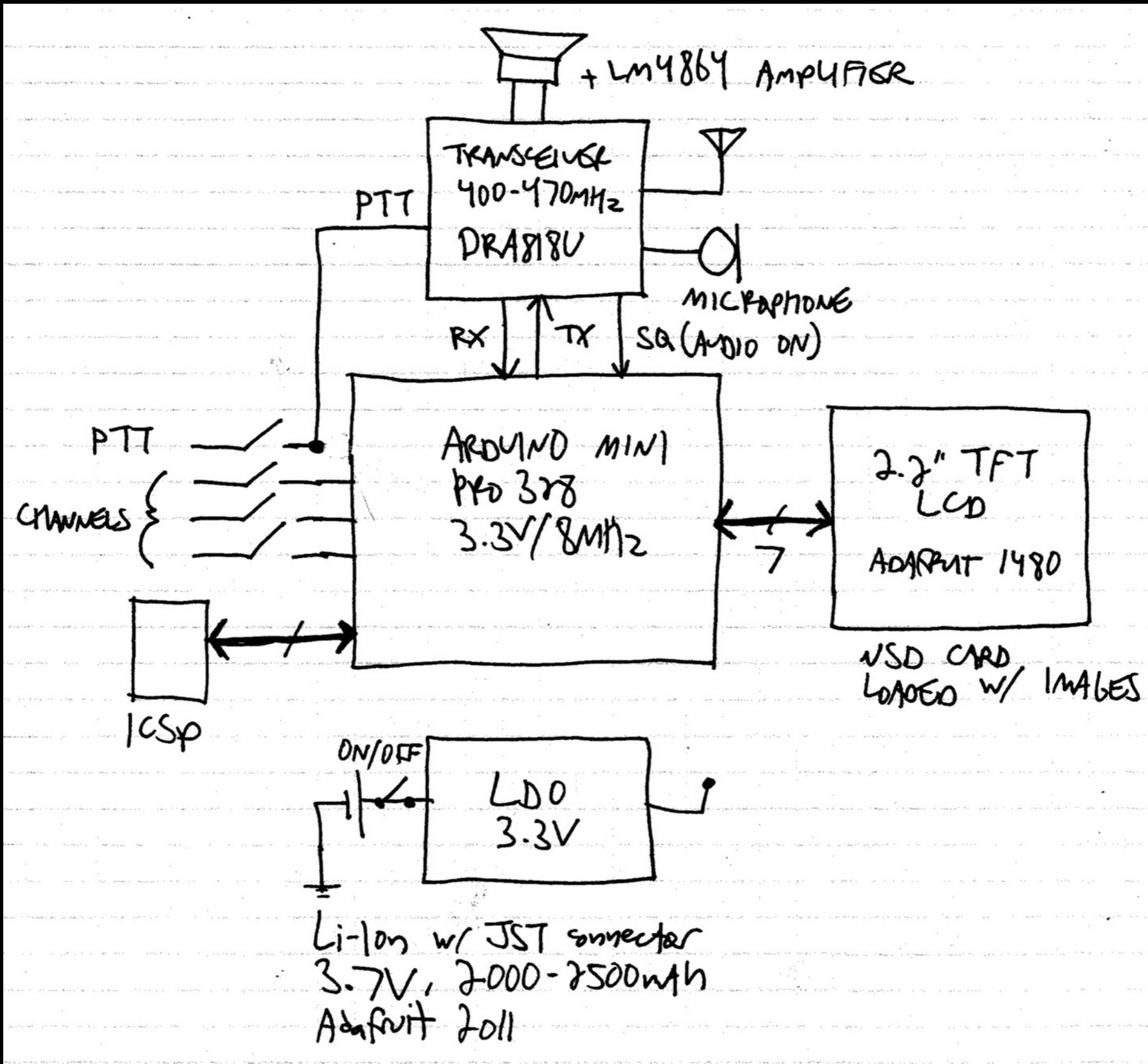
- Mechanical
- Electrical
- Firmware
- Assembly
- Play!



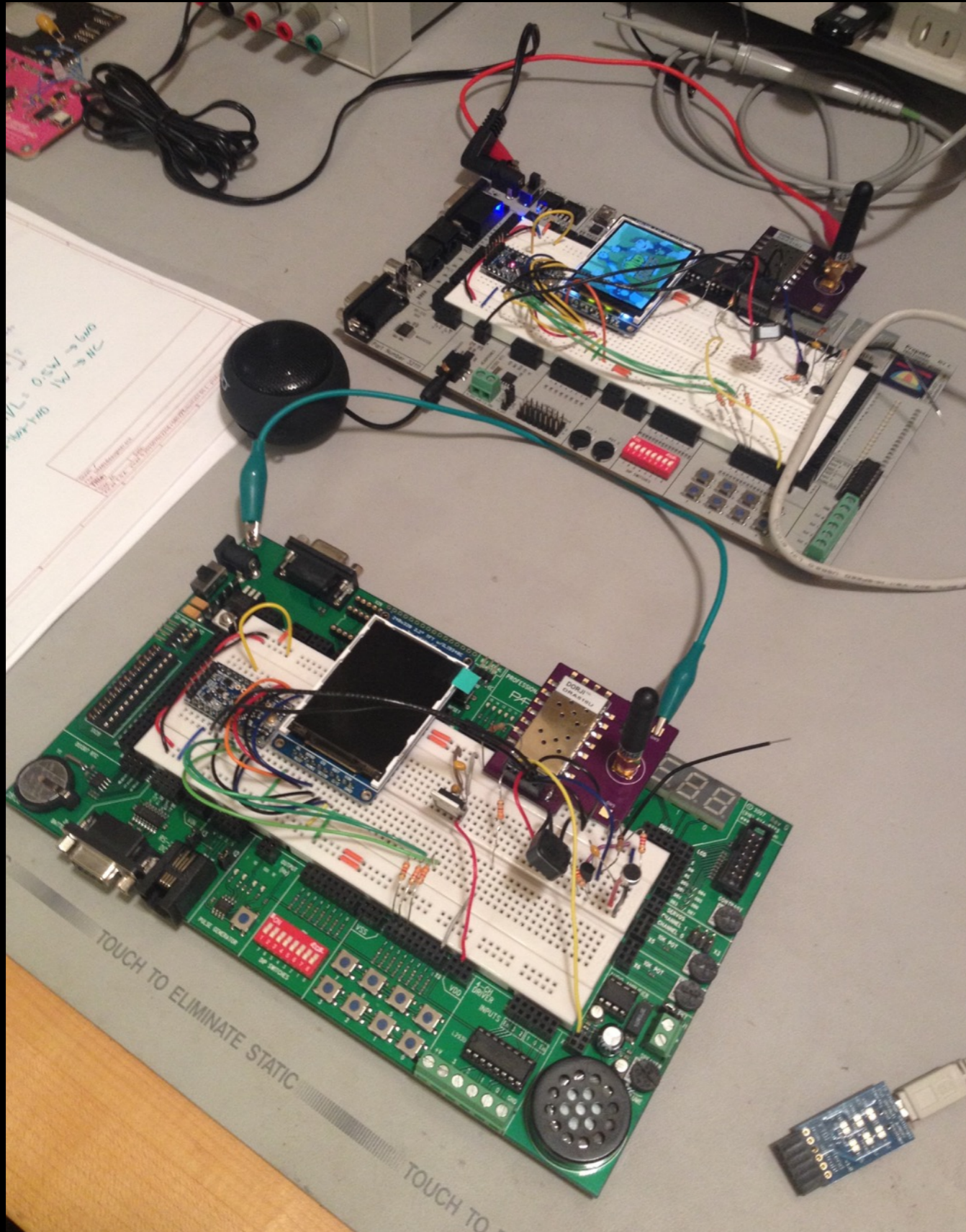
# Mechanical



# Block Diagram



# Development



# Firmware

- Arduino 1.6.5
- SoftwareSerial: Asynchronous communication to radio
- SD (SecureDigital): Image retrieval
- SPI (Serial Peripheral Interface): LCD communication
- Adafruit\_ILI9340: Low-level TFT LCD routines
- Adafruit\_GFX: Graphics support

# Operation

- Hardware initialization: GPIO, SD card, LCD, radio
  - RX frequency, BMP image fixed per unit
- Wild Kratts logo displayed on power-up
- Channel selection: Read button press, change TX frequency of radio, display BMP of target
- Push-to-talk: TX microphone audio to target
  - Independent of Arduino/UI

# Serial Monitor Output

Activating the Creaturepod!

Initializing SD card...OK!

Loading image 'logo.bmp'...OK!

Initializing DRA818U radio transceiver module...OK!

Bandwidth: 12.5 kHz

TX frequency: 422.5375 MHz

TX CTCSS value: 0000

RX frequency: 422.5375 MHz

RX CTCSS value: 0000

Squelch level: 2

Setting TX frequency to 422.5125 MHz...OK!

Loading image 'ben.bmp'...OK!

Setting TX frequency to 422.5250 MHz...OK!

Loading image 'miles.bmp'...OK!

Setting TX frequency to 422.5500 MHz...OK!

Loading image 'guest.bmp'...OK!

Setting TX frequency to 422.5375 MHz...OK!

Loading image 'logo.bmp'...OK!

# Testing

- Fed swept sine wave (300Hz-3kHz) into DRA818U
- Received signal on scanner radio
- Walked out of our front door
- Kept walking
- Nearly reached the end of our neighborhood (~1/2 mile radius)

# Testing

- Prototype TX would occasionally cut out
  - Significant noise on power/ground during TX
  - Added microphone pre-amp (NPN transistor) to increase input level
  - Wrapped antenna w/ solid copper wire (1:1 Choke Balun)
- Problem disappeared in "production" w/ proper PCB layout/ground plane





# Battery Life

	@ 3.3V
IDLE	90.6mA
LCD UPDATE	104mA
RADIO TX	325mA
RADIO RX	91.2mA

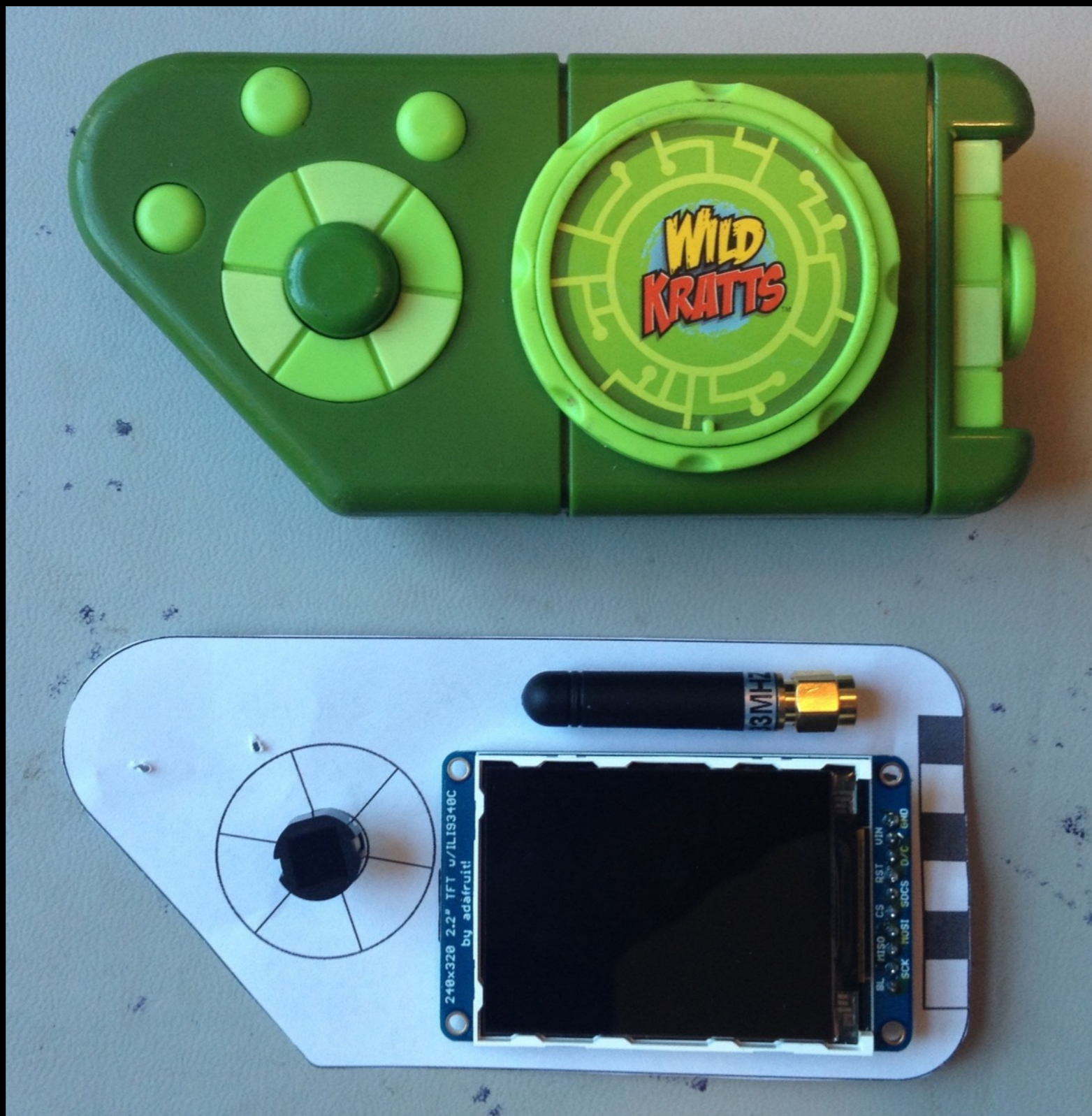
ADARFMT LP-803860 3.7V 2000mAh

0.2C discharge = 900mA to 3.0V

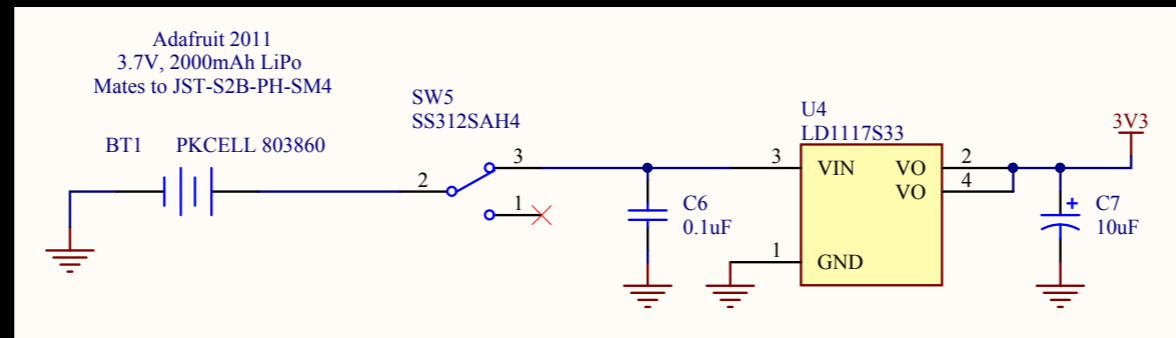
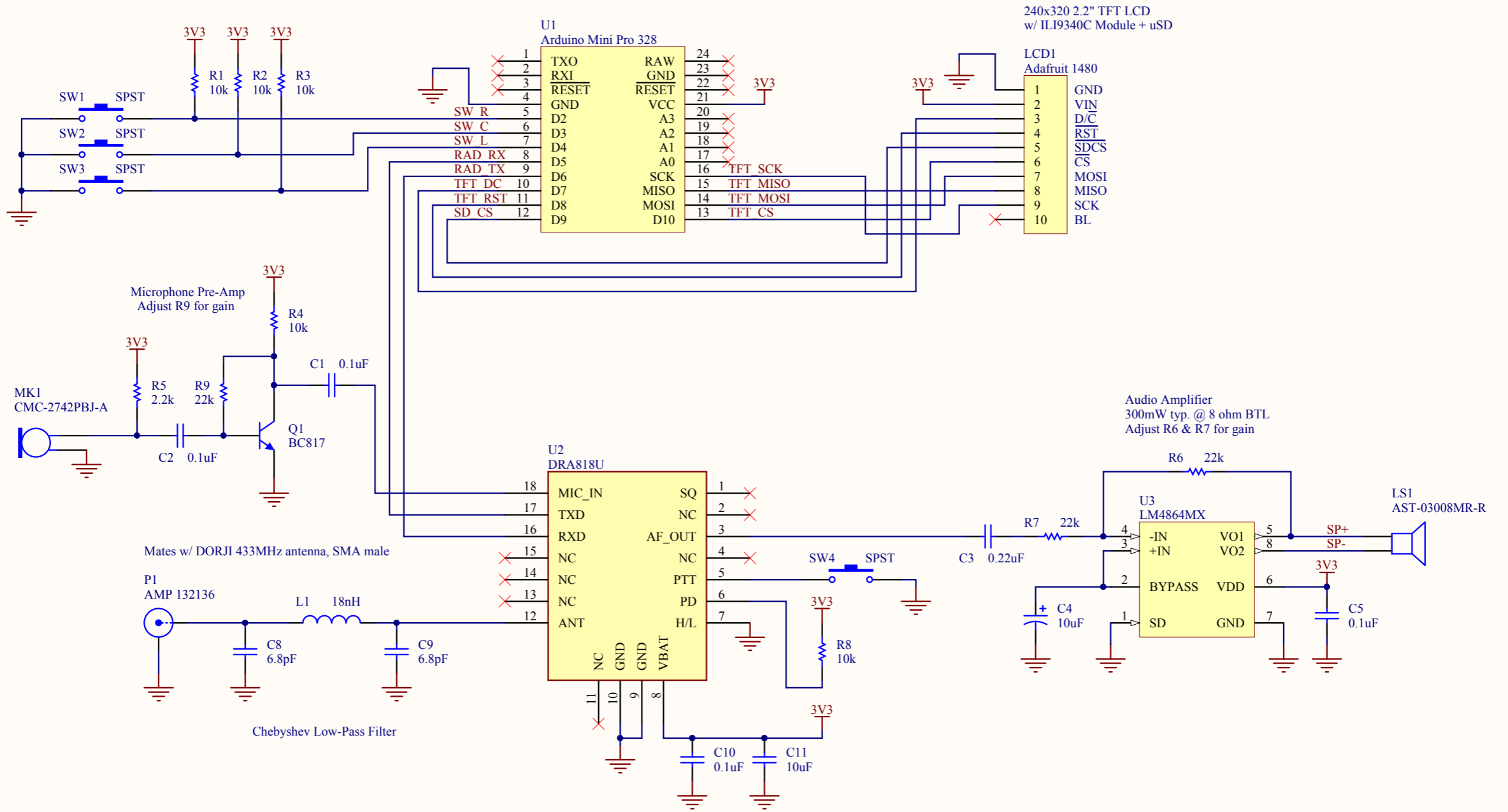
max. continuous = 1C

⇒ ~20 Hours

# Mock up



# Schematic

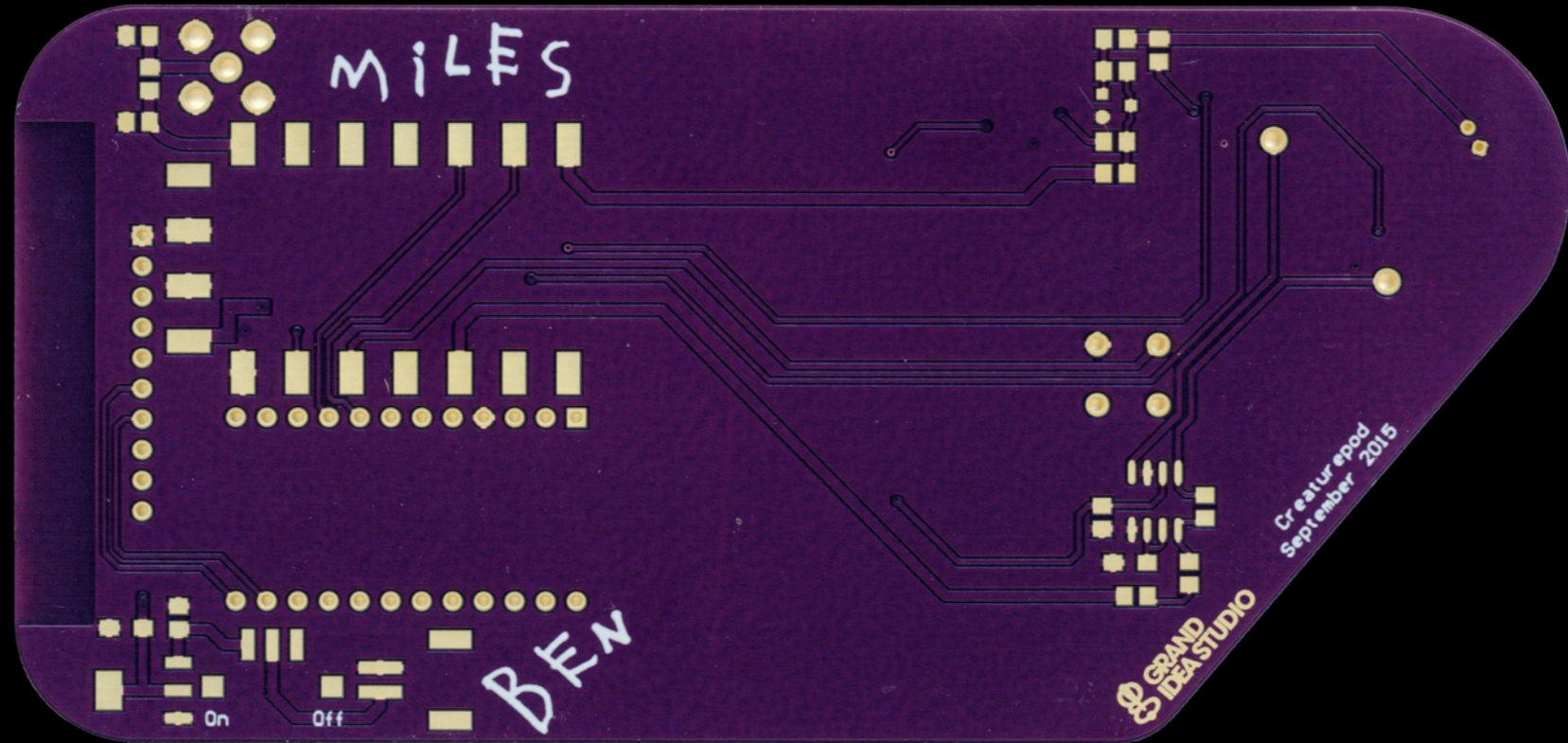
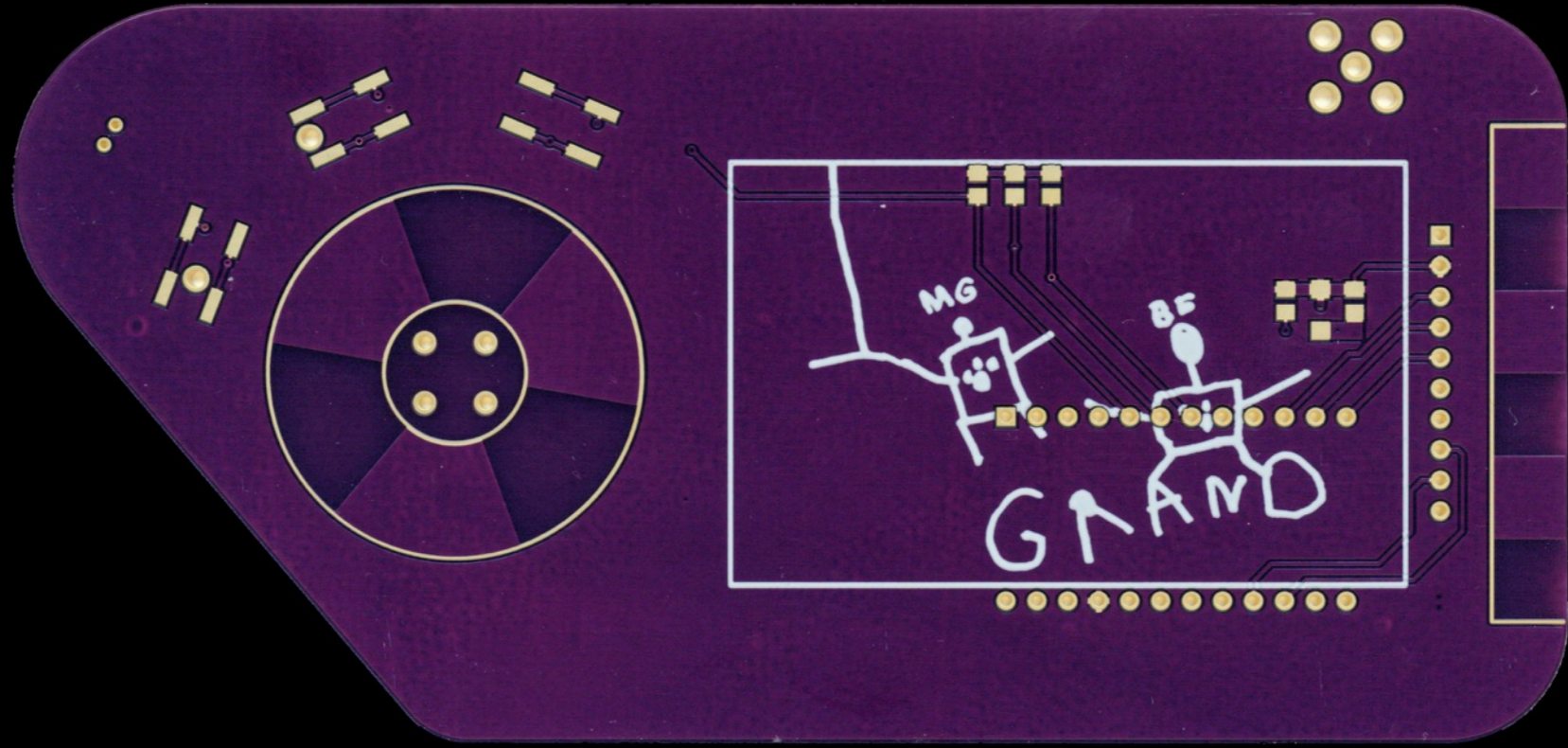


# Bill of Materials

Item	Quantity	Reference	Manufacturer	Manuf. Part #	Distributor	Distrib. Part #	Description
1	1	ANT1	Dorji Applied Technologies	DAA043SA047S	eBay	N/A	Antenna, UHF, 433MHz, 4.7cm L, SMA male, 50R
2	1	BT1	JST Sales America	S2B-PH-SM4-TB(LF)(SN)	Digi-Key	455-1749-1-ND	Connector, 2-position, 2mm P, SMD
3	1	BT1a	Shenzhen PKCELL Battery	803860	Adafruit	2011	Li-Polymer Battery, 3.7V @ 2000mAh, mates w/ JST PH
4	5	C1, C2, C5, C6, C10	Kemet	C0805C104K4RACTU	Digi-Key	399-1167-1-ND	Capacitor, 0.1uF ceramic, 16V, X7R, 0805
5	1	C3	Kemet	C0805C224K5RACTU	Digi-Key	399-3491-1-ND	Capacitor, 0.22uF ceramic, 50V, X7R, 0805
6	2	C4, C7	Kemet	T491A106M016AT	Digi-Key	399-3687-1-ND	Capacitor, 10uF tantalum, 20%, 16V, size A
7	2	C8, C9	Johanson Technology	251R15S6R8CV4E	Digi-Key	712-1373-1-ND	Capacitor, 6.8pF ceramic, 250V, NP0, 0805
8	1	C11	Kemet	C3216X7R1A106M	Digi-Key	445-1602-1-ND	Capacitor, 10uF ceramic, 10V, X7R, 1206
9	1	L1	Sumida America Components	55081803400	Digi-Key	308-1731-1-ND	Inductor, 18nH wire wound, 70mR, 670mA, 0805
10	1	LCD1	N/A	N/A	Adafruit	1480	TFT LCD w/ ILI9340 + microSD card, 2.2", 18-bit
11	1	LS1	PUI Audio	AST-03008MR-R	Digi-Key	668-1136-ND	Speaker, 8R, 150mW, 72dB, 29.85mmD
12	1	MK1	CUI	CMC-2742PBJ-A	Digi-Key	102-1726-ND	Microphone, Electret, Omnidirectional, -42dB
13	1	P1	Amphenol-RF Division	132136	Digi-Key	ACX1232-ND	Connector, SMA female, R/A, 50R
14	1	Q1	NXP Semiconductors	BC817-25,215	Digi-Key	568-1630-1-ND	Transistor, NPN, 45V, 500mA, SOT23-3
15	5	R1, R2, R3, R4, R8	Any	Any	Digi-Key	P10KACT-ND	10k, 5%, 1/8W, 0805
16	1	R5	Any	Any	Digi-Key	P2.2KACT-ND	2.2k, 5%, 1/8W, 0805
17	3	R6, R7, R9	Any	Any	Digi-Key	P22KACT-ND	22k, 5%, 1/8W, 0805
18	3	SW1, SW2, SW3	C&K Components	KSC741J LFS	Digi-Key	CKN10309CT-ND	Switch, Pushbutton, SPST-NO, 50mA @ 32V, 390gf, Blue, SMD
18b	3	SW1, SW2, SW3	C&K Components	KSC421J 70SH LFS	Digi-Key	401-1780-1-ND	Switch, Pushbutton, SPST-NO, 50mA @ 32V, 170gf, Yellow, SMD
19	1	SW4	E-Switch	KS-04Q-01	Digi-Key	EG4797-ND	Switch, Pushbutton, SPST-NO, 10mA @ 35V, Round
20	1	SW5	NKK Switches	SS312SAH4	Digi-Key	360-3250-ND	Switch, Slide, SPDT, R/A, 0.4VA @ 24V
21	1	U1	SparkFun Electronics	DEV-11114	Adafruit	2377	Module, Arduino Mini Pro 328, 3.3V, 8MHz, DIP-24W
22	1	U2	Dorji Applied Technologies	DRA818U	eBay	N/A	Module, UHF Voice Band Transceiver, 400-470MHz
23	1	U3	National	LM4864MX/NOPB	Digi-Key	296-35420-1-ND	IC, Audio Amplifier, 725mW @ 8R, SOIC-8
24	1	U4	STMicroelectronics	LD1117S33CTR	Digi-Key	497-1241-1-ND	IC, Linear Regulator, LDO, 3.3V, 800mA, SOT223-3
25	1	PCB	OSH Park	CREATUREPOD	N/A	N/A	PCB, Fabrication

- Components from Adafruit, Digi-Key, eBay
- Total cost per unit = \$106.97 (!)

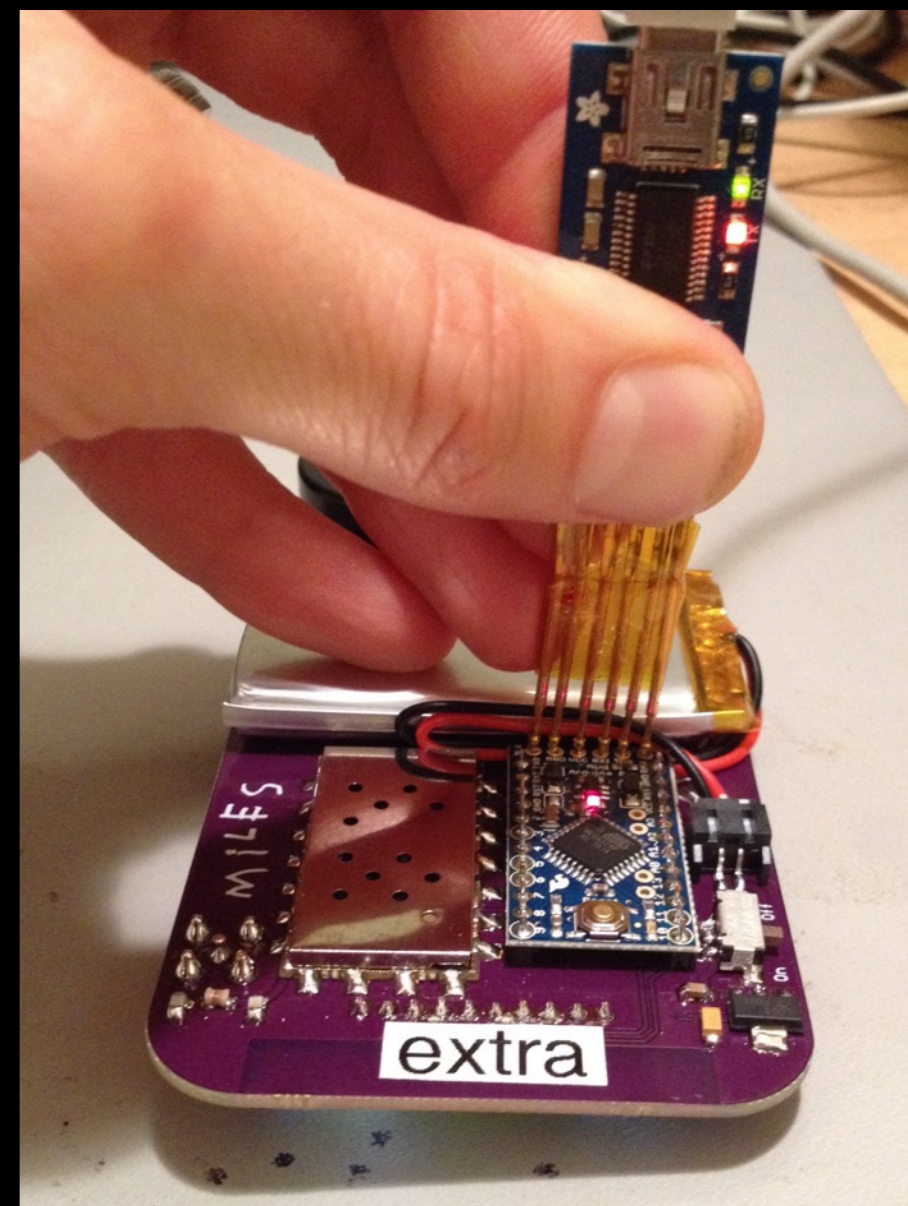
# PCB



# Assembly



# Assembly



# A Real-Life Creaturepod!





# A Real-Life Creaturepod!



# Challenges

- Engineering is "boring"
- Transceiver frequencies require radio license
- Fully costed BOM = \$\$\$
- Fragile!

TOTALLY WORTH IT

# Make One

- [www.grandideastudio.com/portfolio/creaturepod](http://www.grandideastudio.com/portfolio/creaturepod)
  - \*\*\* Schematic, source code, BOM, block diagram, Gerber plots, assembly drawing
- <http://oshpark.com/profiles/joegrand>
  - \*\*\* Bare boards

# **ACTIVATE ENGINEER POWERS!**

