IR HUB

CRITICAL DESIGN REVIEW

By:

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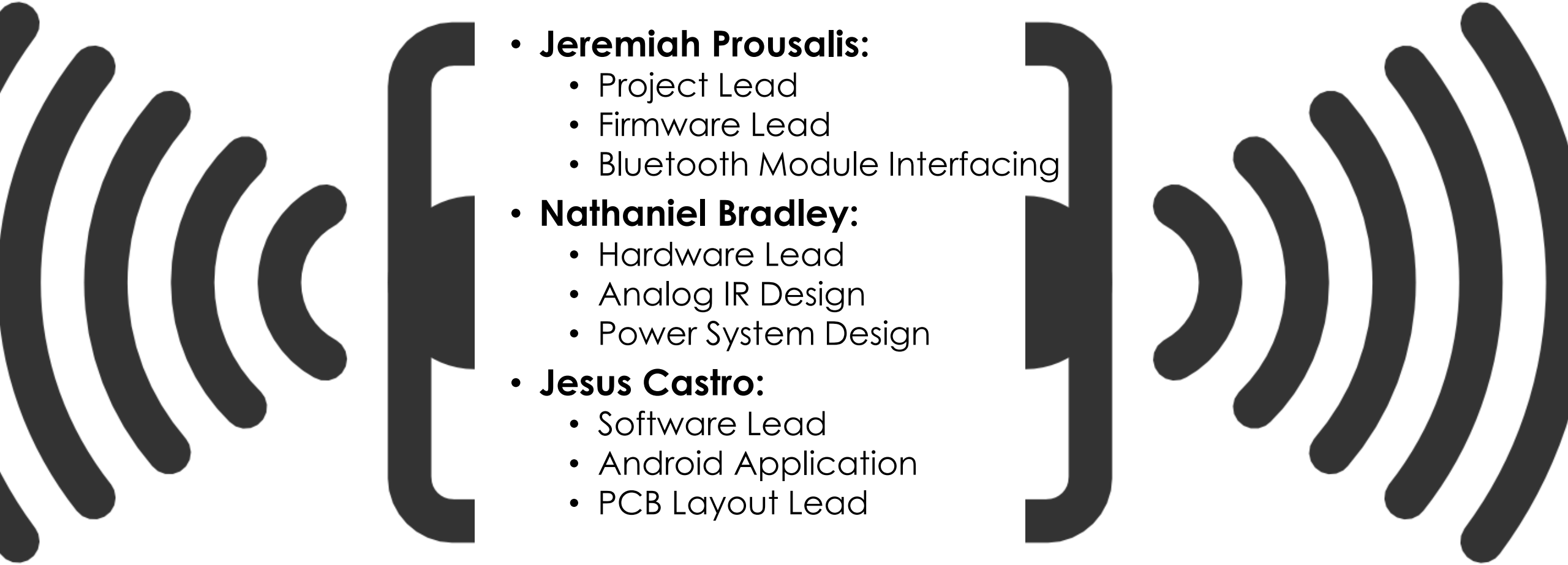
DEVELOPMENT TEAM:



- **Jeremiah Prousalis:**
  - Project Lead
  - Firmware Lead
  - Bluetooth Module Interfacing
- **Nathaniel Bradley:**
  - Hardware Lead
  - Analog IR Design
  - Power System Design
- **Jesus Castro:**
  - Software Lead
  - Android Application
  - PCB Layout Lead

PRODUCT DESCRIPTION:

- IR Hub will feature an MCU connected to a **Bluetooth Low Energy Module**
- The BLE Module will enable users to interact with the Hub via an accompanying **Android app**
- An **IR receiver** will be used to read and store button codes from users' remote controls
- An array of **IR LEDs** will be arranged around the perimeter of the PCB allowing known button codes to be rebroadcast on command

APPLICATION:

- **IR Hub** will solve the problem of cluttering your living room with one or more infrared remotes by turning your **phone** into a **universal remote**.
- The **IR sensor** will allow the Hub to act as a truly *universal* remote by enabling the device to **learn** the outputs of any remote control no matter how obscure the brand.
- This will all be housed in a domed casing intended to be mounted in a central location of a user's room, and any IR signals transmitted provide **360° room coverage.**

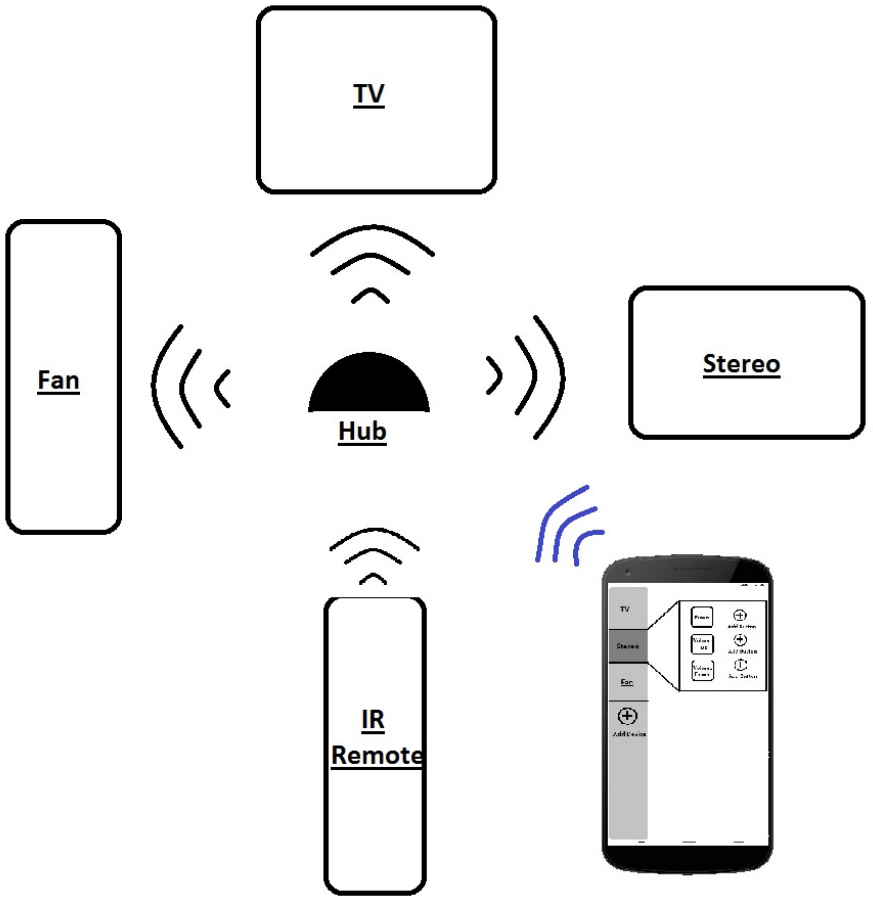
CRITICAL ELEMENTS:

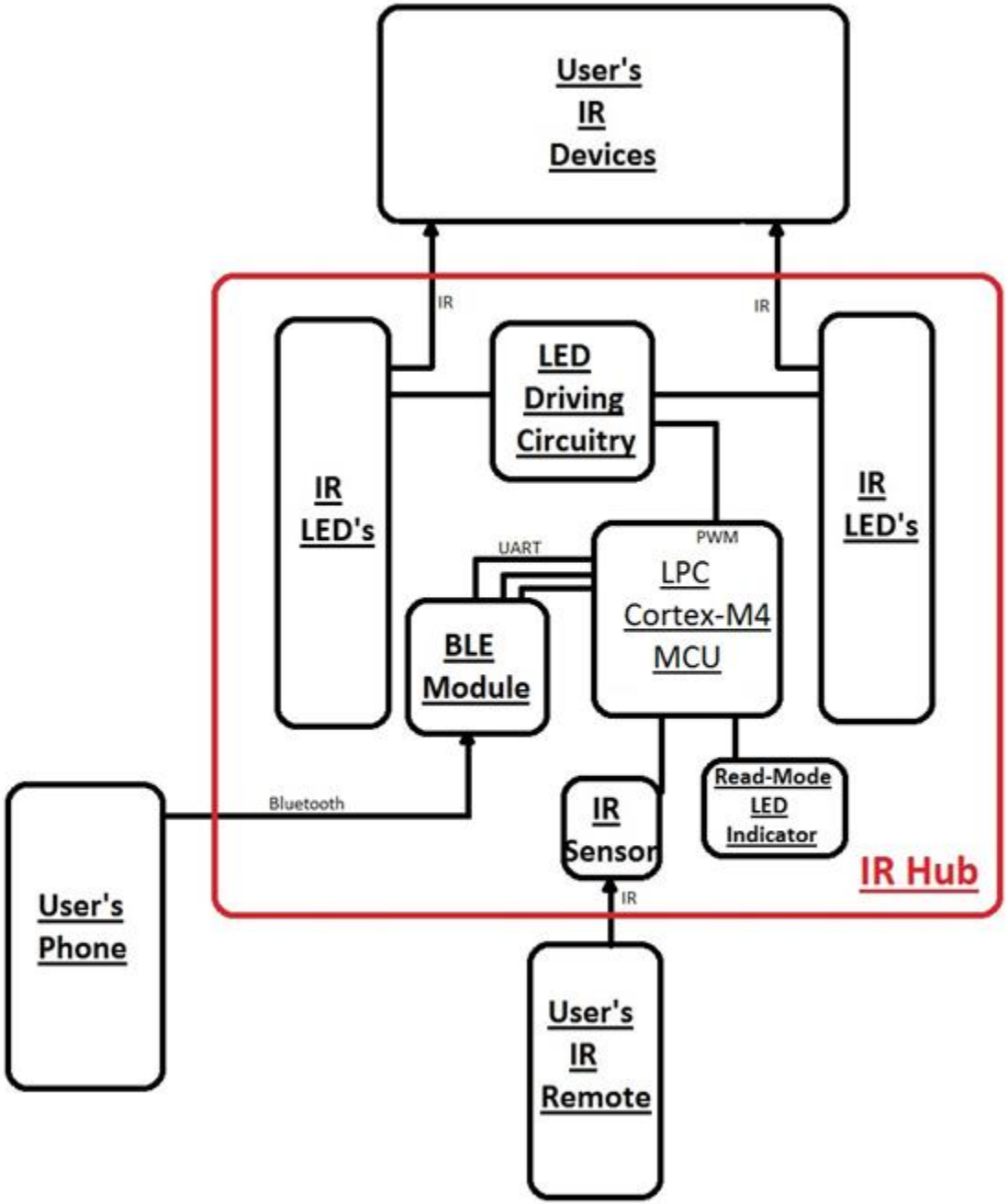
- Precise signal capturing

- Precise signal broadcasting

- Responsive handling of user input

BLOCK DIAGRAM:



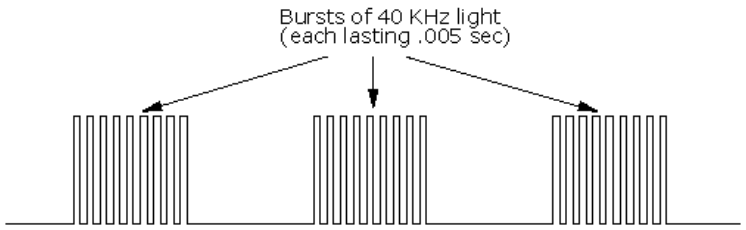


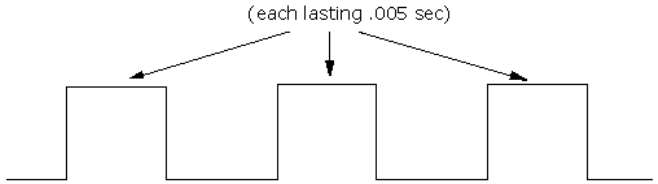
PARTS:

- **Microprocessor**
  - LPC4088
    - 512kB Flash
      - persistent storage used for remote codes
    - 12 bit ADC
      - 400kHz Conversion Rate
    - PWM Capture Pin
    - 120MHz Clock
    - 2.4V-3.6V Supply Voltage
    - UART Interface
    - On-Board PWM

SUB-SYSTEMS:

- **Power**
  - Optional wall or battery power
- **Bluetooth**
  - Bluetooth Low Energy module allowing users to command Hub to either learn or transmit a remote code
- **IR Receiver**
  - Infrared phototransistor for reading raw signal from remotes



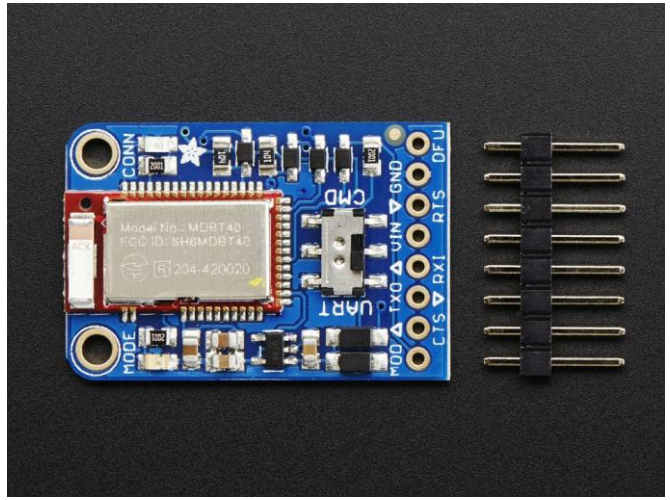


- **IR Transmitter**
  - 8 infrared LEDs arranged around the perimeter of the PCB
- **User Interface**
  - Android Application allowing users to create, organize, and activate buttons for various devices

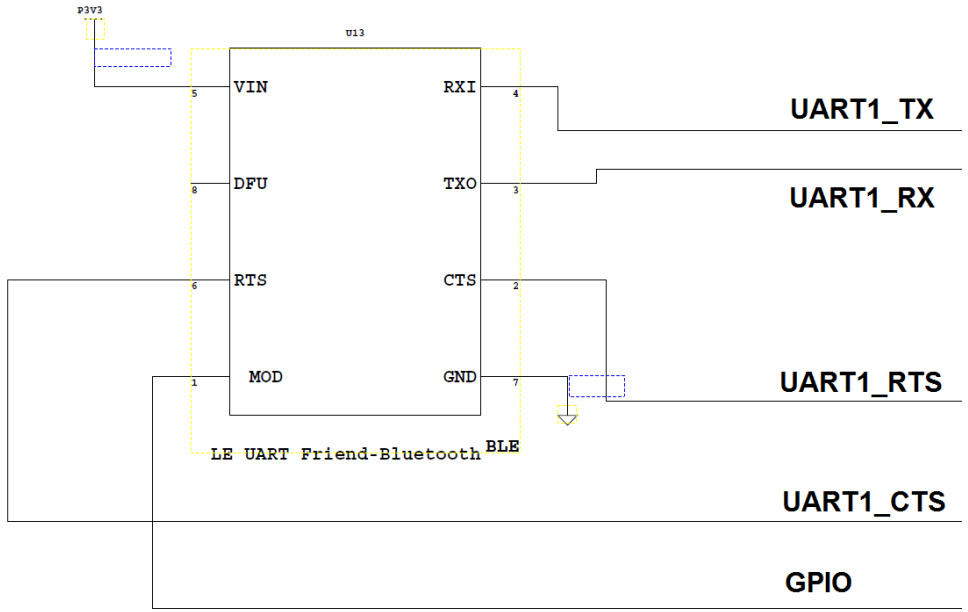
POWER DISTRIBUTION:

- 9V input, regulated down to 3.3V to supply entire PCB
- Jumper to select between wall or battery power
  - Barrel Jack with 9V input on wall power
  - 9V battery on battery power
- 1 Analog and 1 Digital Power Plane
  - IR Receiver/Transmitter supply analog plane
  - Rest digital plane

PARTS:

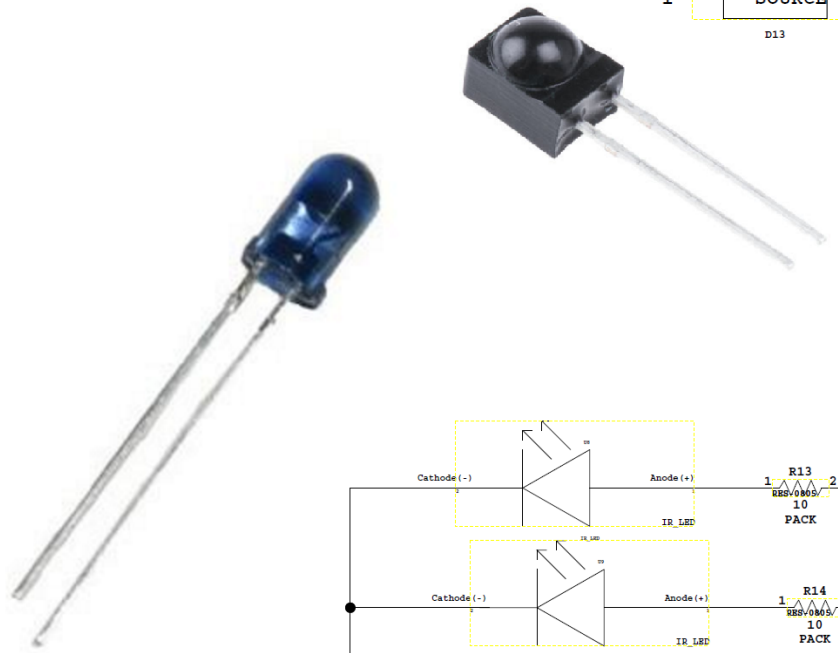


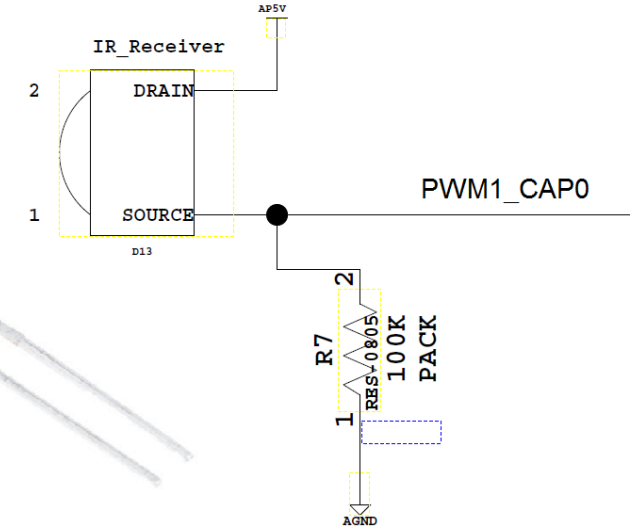
- **Bluetooth Module**
  - Adafruit Bluefruit LE
    - UART interface at 9600 baud
    - HW flow control (CTRS, RTS)
    - Simple AT command set for configuration
    - 3.3V Supply Voltage
    - 20 mA peak current consumption
    - On-board ADC for battery read
  - Through hole female socket connectors for mounting module

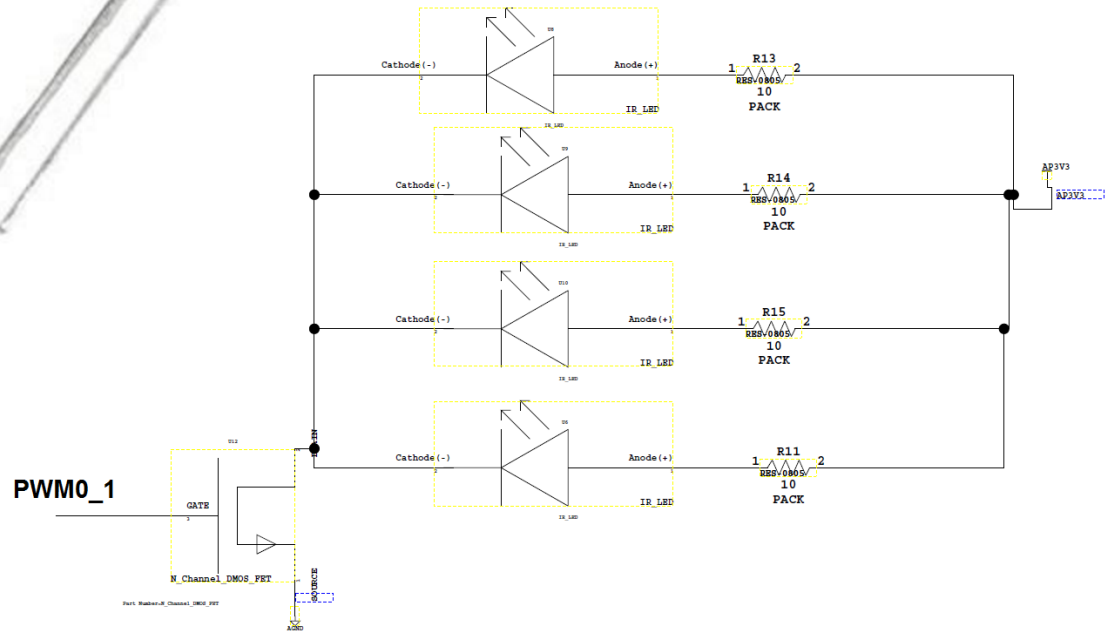


PARTS:

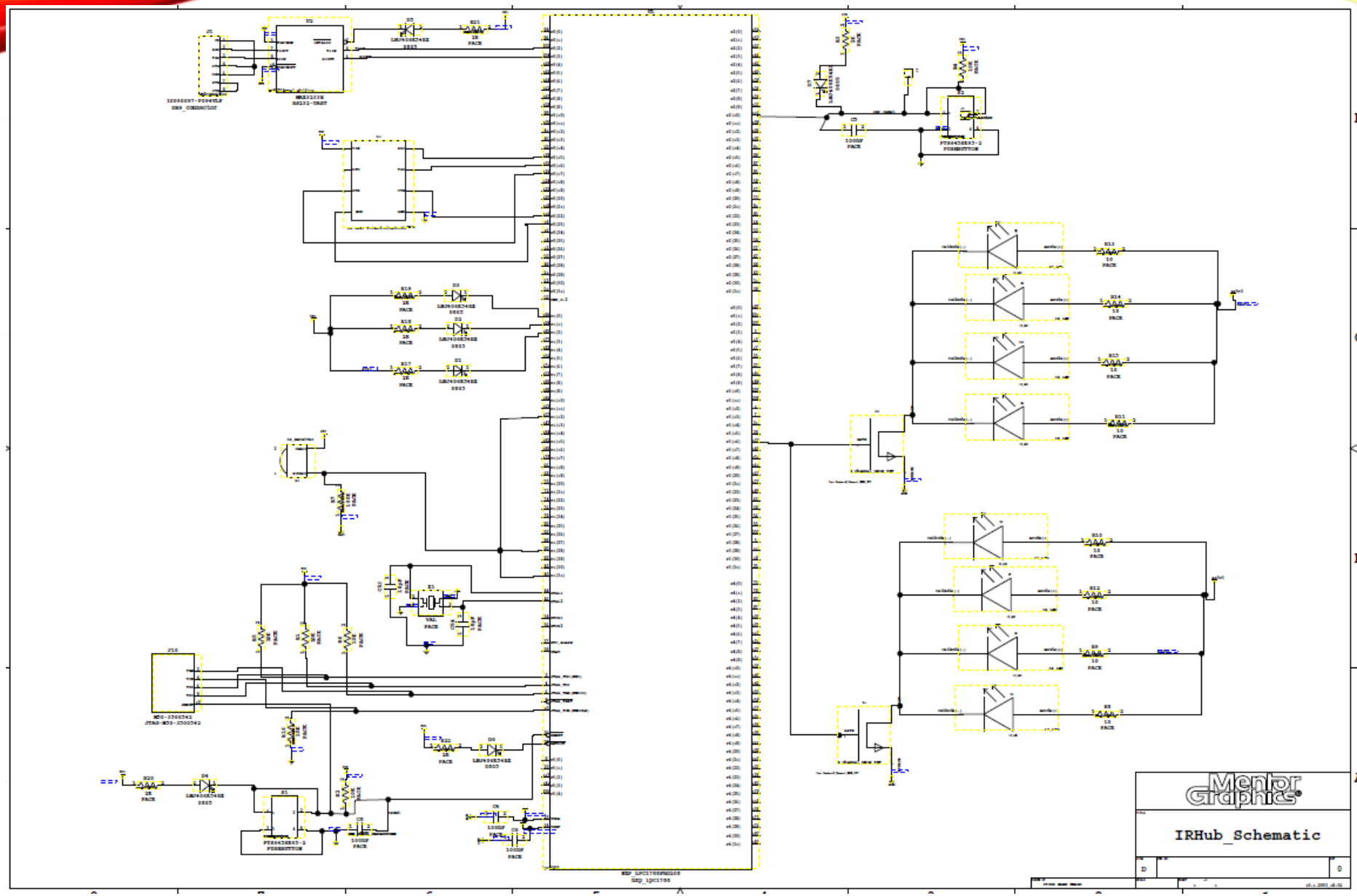
- **IR I/O**
  - BPV22 IR Phototransistor
  - 8 TSAL6200 IR Emitters
    - 940nm wavelength
    - 1.35V
    - 100mA



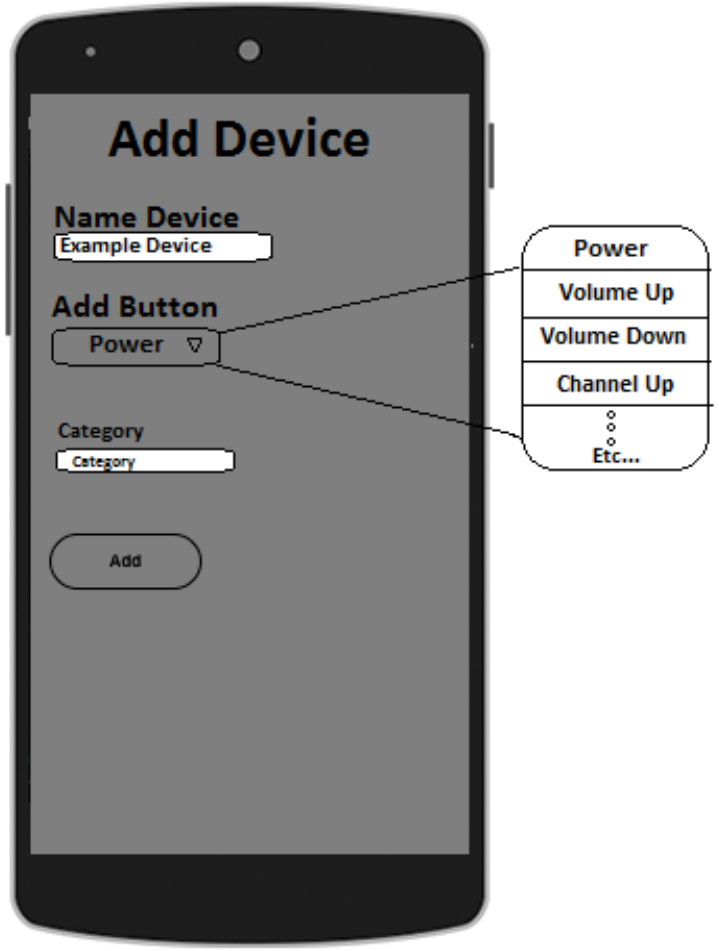


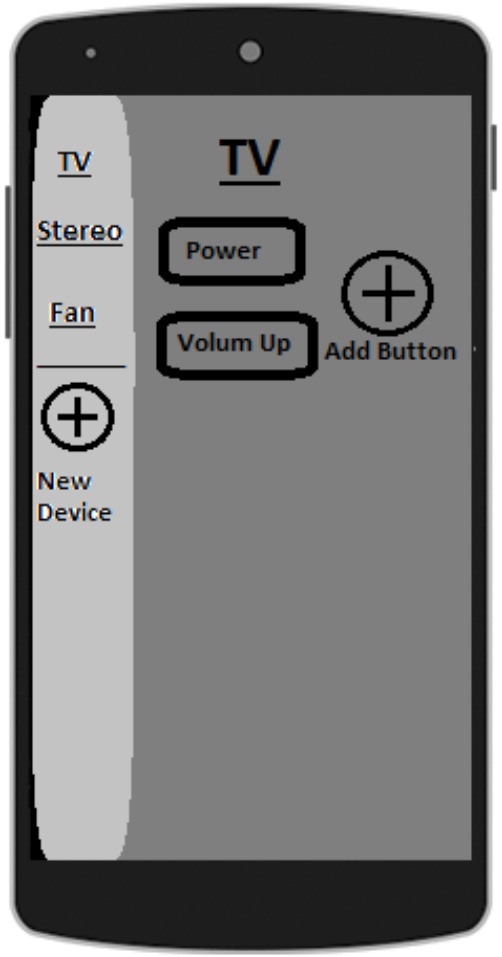


SCHEMATIC:



ANDROID APPLICATION MOCKUP:



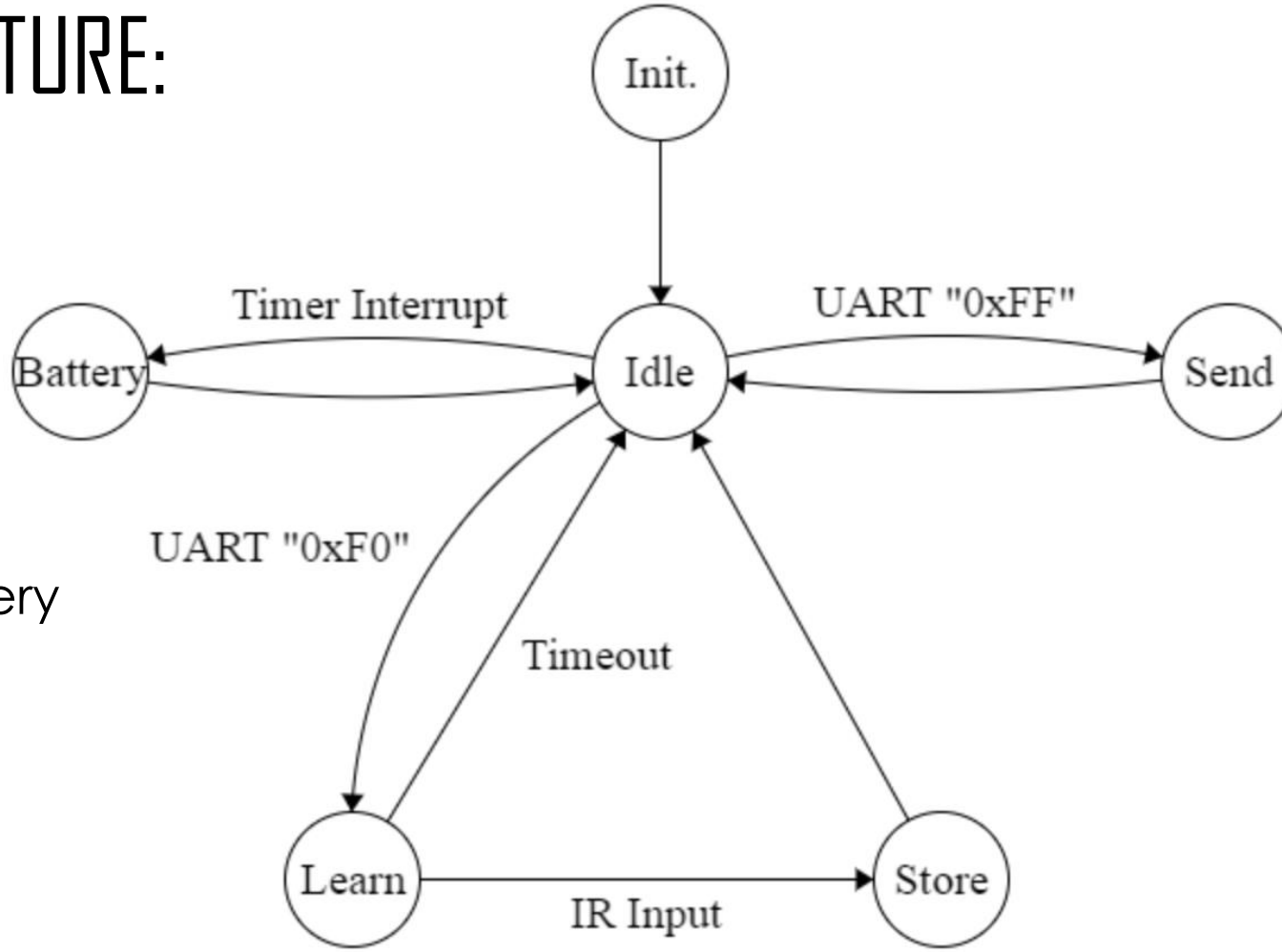


TECHNOLOGY REUSE:

- BLE Module
  - Existing Adafruit BLE Libraries for nRF51 based modules
  - Proprietary Nordic UART BLE connection profile
    - Nordic UART Service (UUID: 6E400001-B5A3-F393-E0A9-E50E24DCCA9E)
      - TX Characteristic (UUID: 6E400002-B5A3-F393-E0A9-E50E24DCCA9E)
      - RX Characteristic (UUID: 6E400003-B5A3-F393-E0A9-E50E24DCCA9E)
- LPCOpen
  - Open source libraries and code

FIRMWARE STRUCTURE:

- **Battery Read**
  - BLE module contains ADC and battery read AC Command
  - Periodic interrupt reads battery level
  - Red LED indicator blinks when battery is low

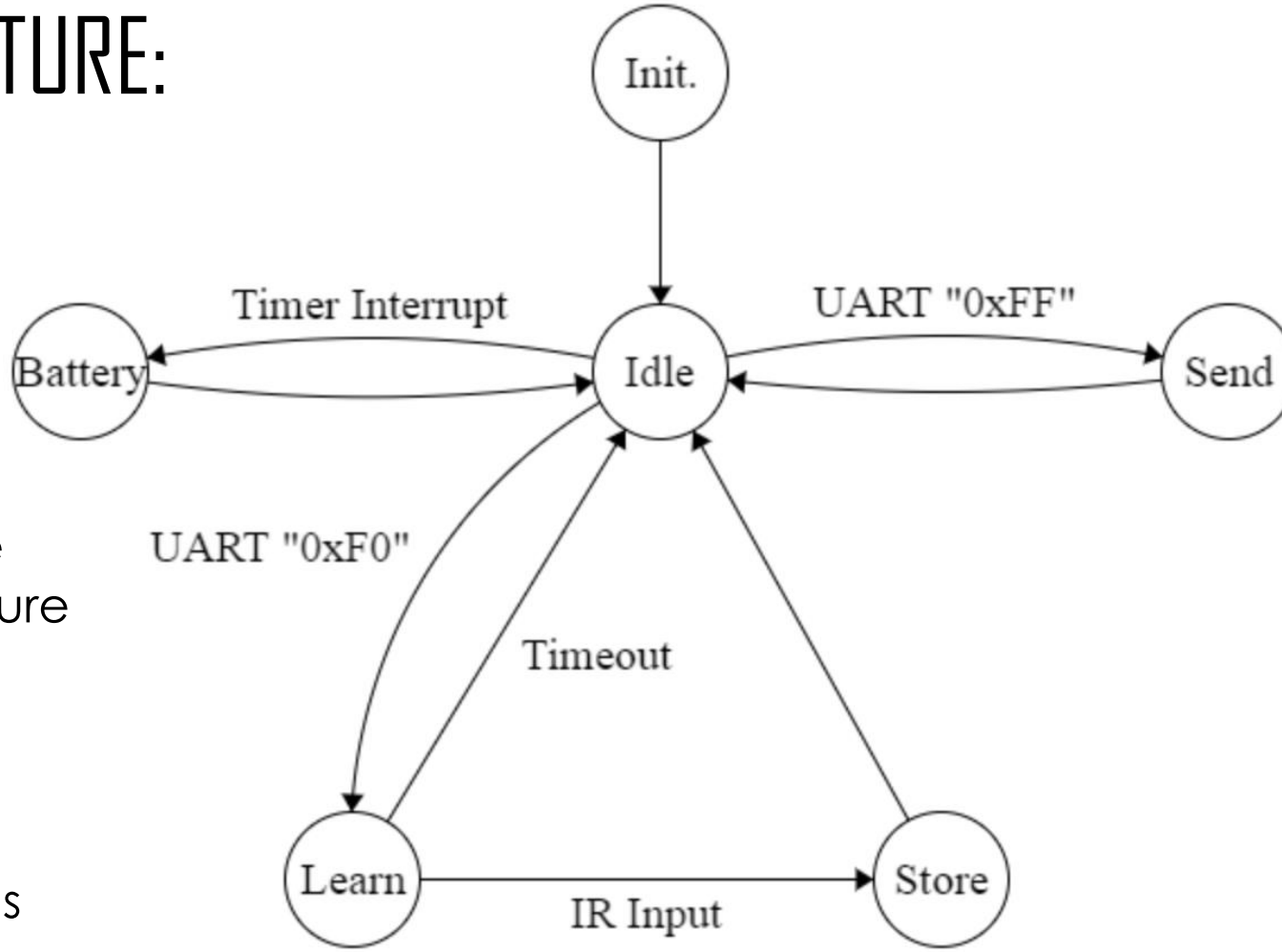


FIRMWARE STRUCTURE:

- **Learning Mode**
  - BLE command over UART bridge wakes MCU from idle state

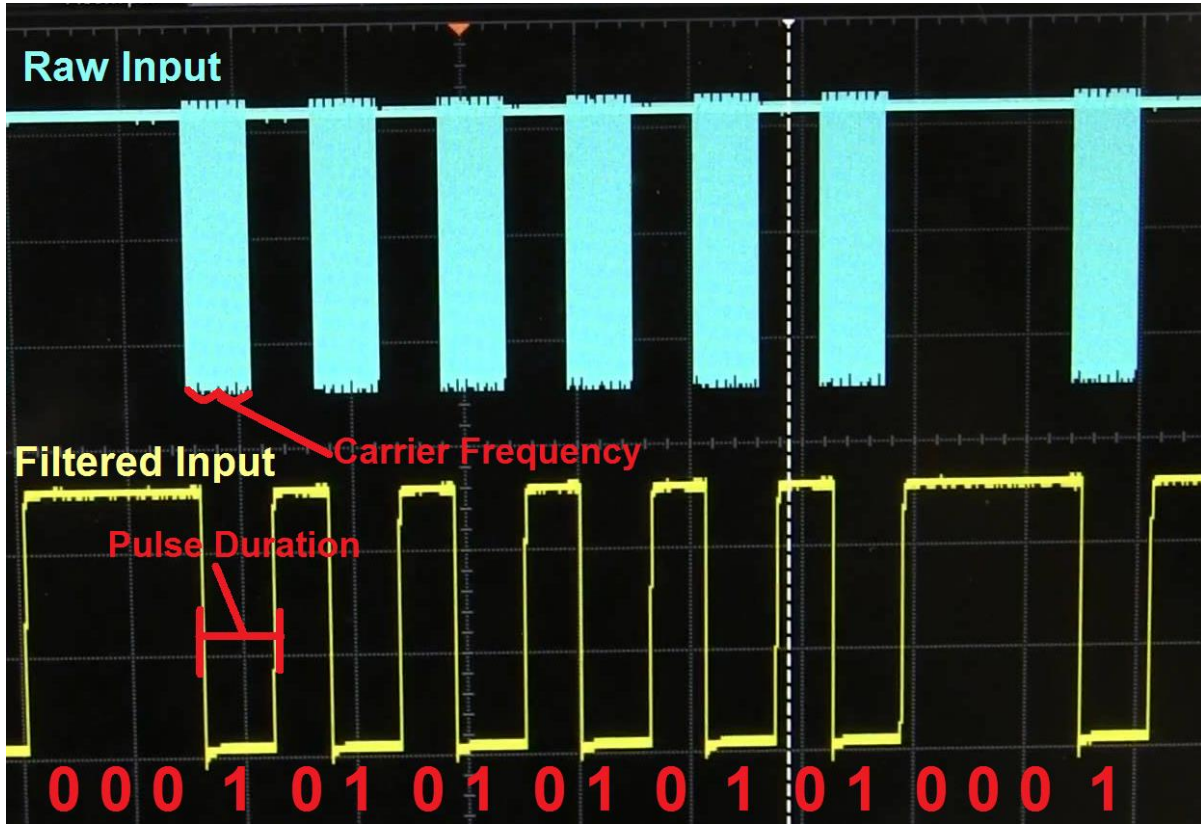
Start	0xF0	<ID>	Stop

  - Frame "**0xF0**" indicates learning mode
  - **ID** sent for addressing button in the future
  - **Yellow LED** indicates state change
  - Timeout timer started
  - **IR Receiver** interrupts enabled
  - **PWM1_CAP0** reads in remote signal
  - **Green LED** indicates whether signal has been received



FIRMWARE STRUCTURE:

- **Store**
  - Input data is processed and compressed
  - Data is broken down into 3 key pieces of information:
    - Carrier Frequency
    - Pulse Duration
    - Code
  - Data is stored in flash, indexed according to ID previously provided by phone

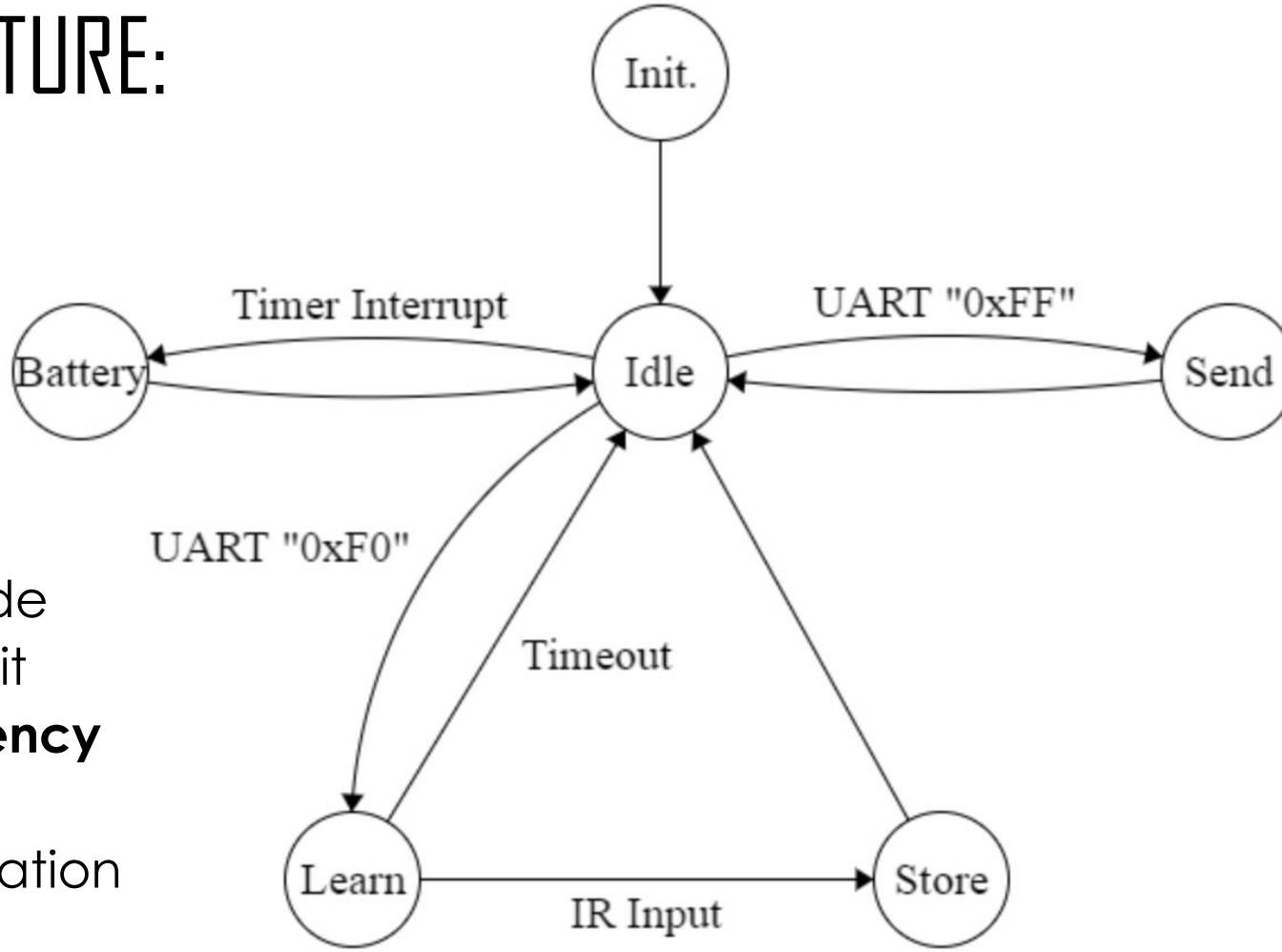


FIRMWARE STRUCTURE:

- **Send**
  - BLE command over UART bridge wakes MCU from idle state

Start	0xFF	<ID>	Stop

  - Frame "**0xFF**" indicates learning mode
  - **ID** indicates index of code to transmit
  - **PWM0_1** configured to **carrier frequency**
  - **Code** is iterated through, bit by bit delaying by **pulse duration** each iteration



BILL OF MATERIALS:

Description	Manufacturer	Manuf Part #	Units per Board	Total Units	Unit Price	Total Price
uController	NXP Semiconductors	LPC4088FBD208	1	4	$12.7800	$51.12
RS232 Level Shifter	Products	MAX3233ECWP+G	1	4	$7.1700	$28.68
Pushbutton	C & K Components	PTS645SK95-2 LFS	2	8	$0.1900	$1.52
Yellow Test LEDs	Lite-On	LTST-C170YKT	1	4	$0.3700	$1.48
Green Test LEDs	Lite-On	LTST-C170GKT	1	4	$0.3300	$1.32
IR LED Emitter	Vishay	TSAL6200	8	32	$0.57	$18.24
IR Photo Receiver	Vishay	BPV22NF	1	4	$1.11	$4.44
Red Test LEDs	Lite-On	LTST-C170CKT	5	20	$0.0823	$1.65
10K Resistors	Vishay	CRCW080510K5FKEA	6	24	$0.0050	$0.12
100K Resistors	Vishay	CRCW0805100KJNEA	1	4	$0.10	$0.40
10 Ohm Resistors	Vishay	CRCW080510R0JNEA	8	32	$0.10	$3.20
2K Resistors	Vishay	CRCW08052K00JNEA	7	28	$0.0030	$0.08
1 nF Capacitors	Kemet	C0805C102J5GACTU	9	36	$0.0780	$2.81
4.7 uF Capacitors	Kemet	C0805C475K4PACTU	9	36	$0.1460	$5.26
100 nF Capacitors	Kemet	C0805C104J5RACTU	31	124	$0.0360	$4.46
1 uF Capacitors	Kemet	C0805C105K4RACTU	2	8	$0.0890	$0.71
JTAG	Harwin	M50-3500542	1	4	$0.0000	$0.00
Berg Connector	FCI	68001-220HLF	1	4	$0.0690	$0.28
DB9 Connector	FCI	10090097-P094VLF	1	4	$0.0000	$0.00
BLE Module Headers	Preci-Dip	801-87-008-10-001101	1	4	$0.6000	$2.40
Barrel Power Jack	CUI	PJ-102AH	1	4	$1.1800	$4.72
3v3 Regulator	Texas Instruments	LM1084ISX-3.3/NOPB	3	12	$2.66	$31.92
N-Chanel MOSFET	Microchip Technology	VN0104N3-G	2	8	$0.58	$4.64
BLE Module	Adafruit	Adafruit Bluefruit LE UART	1	4	$17.50	$70.00
					Total:	$239.45

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Questions?