



CSS: CAR SENTRY SYSTEM

Group 38

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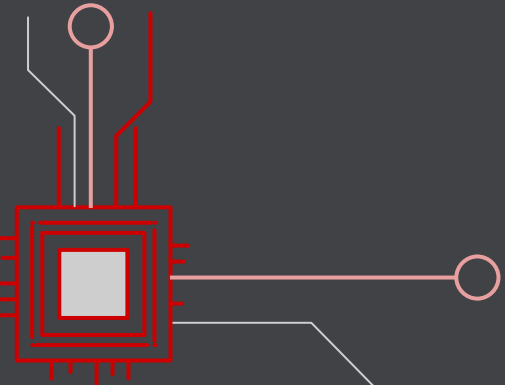


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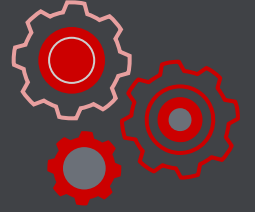
06

QUESTIONS?

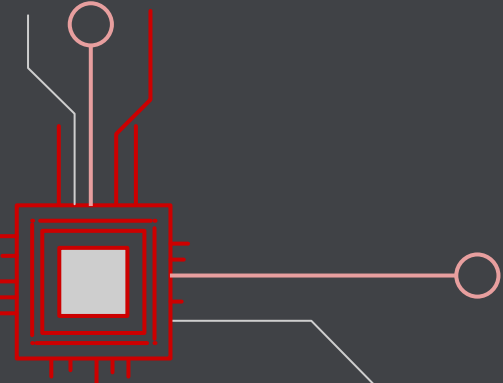
Open Question &
Answer Session



01



PROJECT OVERVIEW





MOTIVATION

- Driving is a dangerous activity
 - Hit & Run/Reckless Driving
- Difficulty in Memorization
- Wide range of applications
 - Parking
 - Tolls
 - Grounds Management



GOALS AND OBJECTIVES



GOAL:

Produce a low-cost, portable license plate scanner for the average day-to-day driver

OBJECTIVES:

- Scan license plate information for enclosed, 4-wheel civilian vehicles
- Plug-and-Play functionality
- Lightweight & Portable Design
- Crash Survivability
- Prevent Obstruction in Driver View
- Build to IEEE/IEC/UL Standards
- Modular codebase
- Accessible and Convenient to Users (Mobile Application)



SPECIFICATIONS

Demonstrable

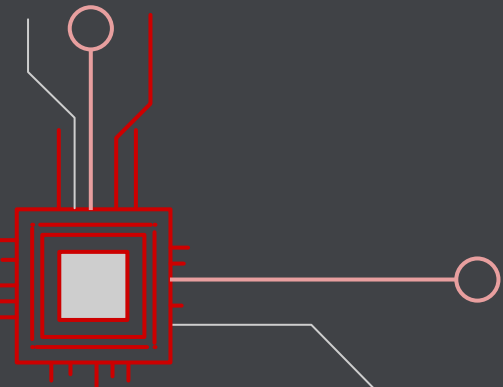
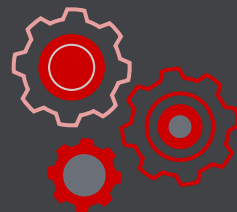
Component	Parameter	Design Specification
Battery	Discharge Life	3-5 days (Avg. 40-60 mins/day)
Camera	Resolution	1080p with accuracy of $\geq 90\%$
Camera	Frame Rate	Process video feed ≥ 20 fps
System	Dimensions	Will not exceed 5"x4"x4"
System	Weight	< 2lb
Enclosure	Survivability	Readable storage after 2-story drop



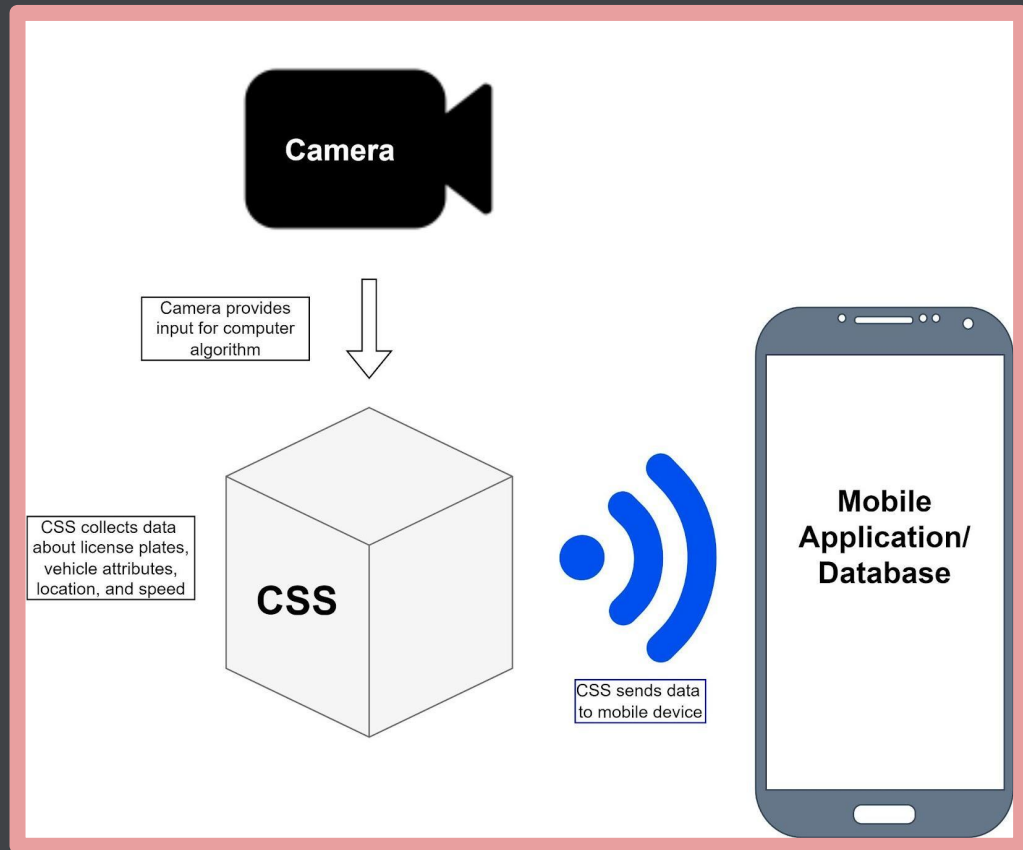


02

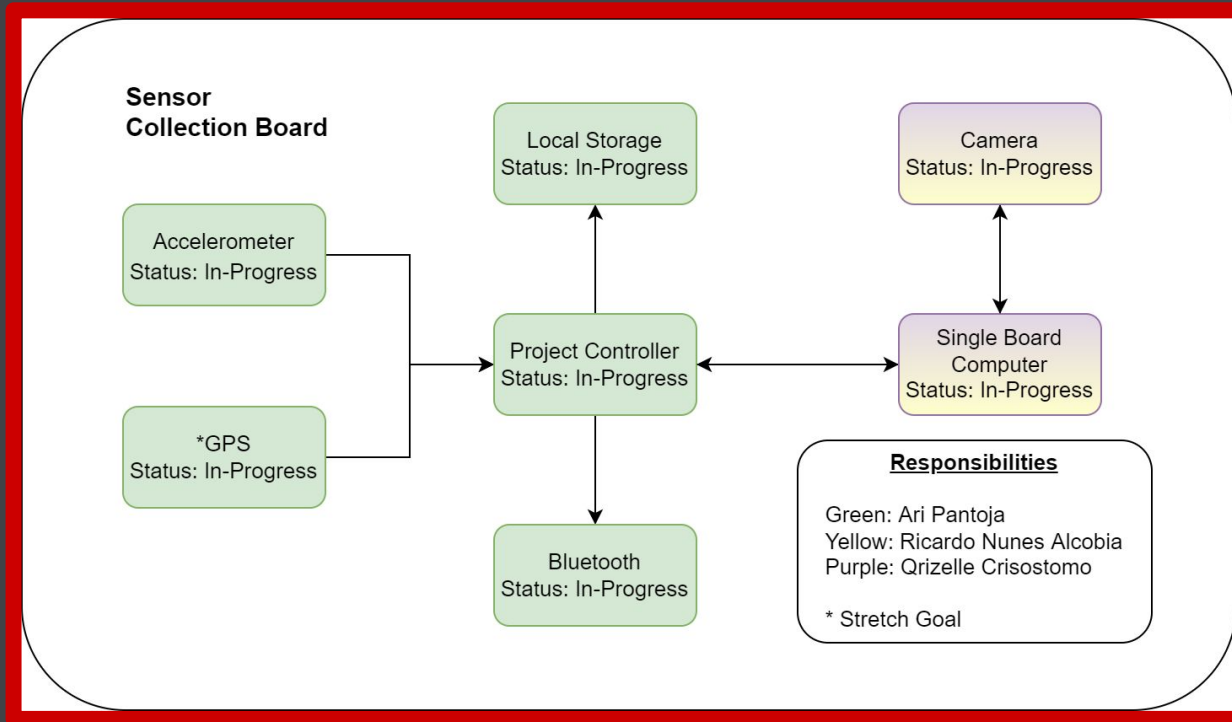
DESIGN



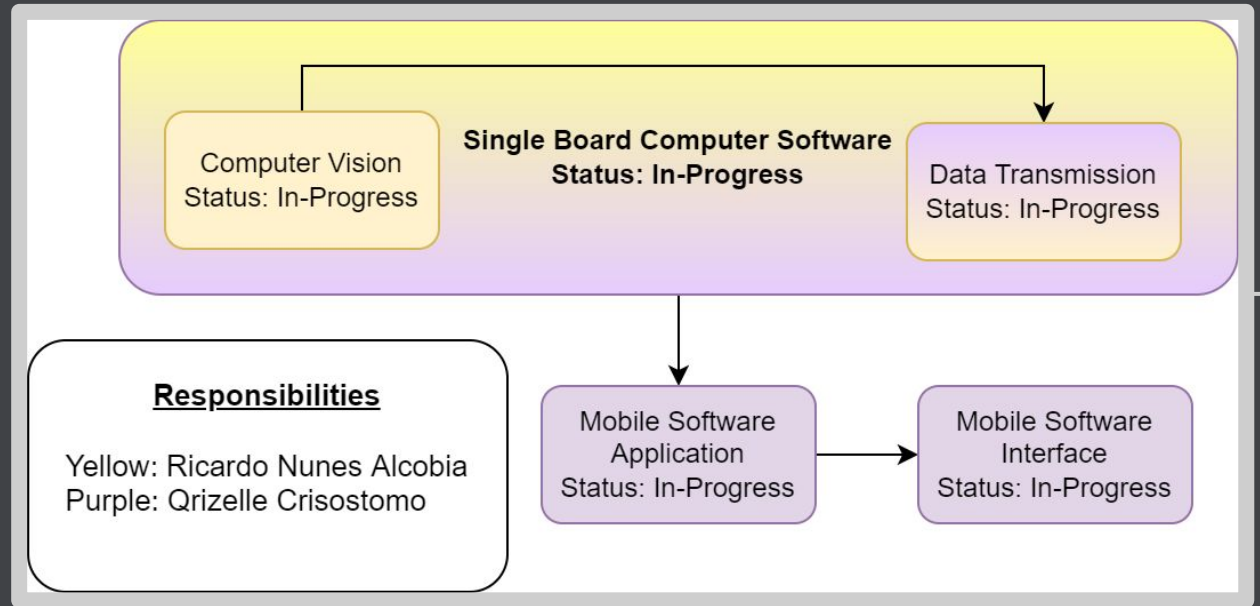
HIGH-LEVEL OVERVIEW



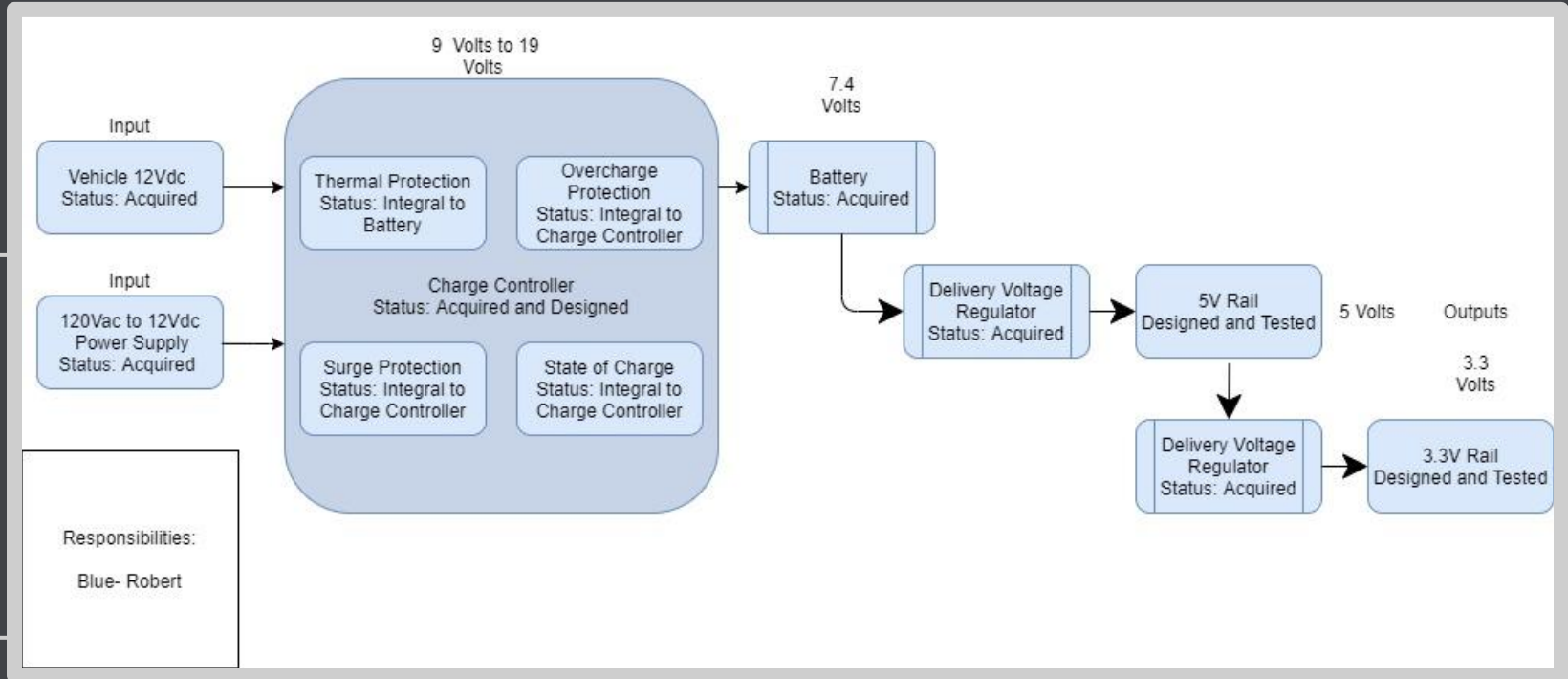
ELECTRONICS BLOCK DIAGRAM



SOFTWARE BLOCK DIAGRAM

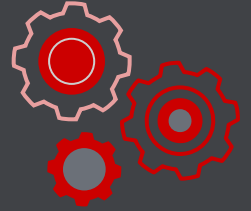


POWER BLOCK DIAGRAM

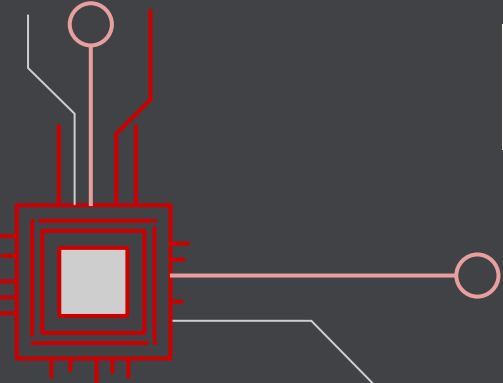




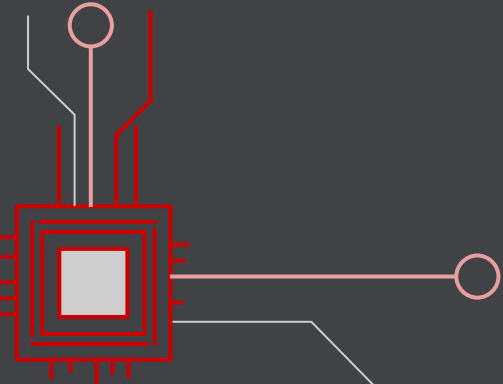
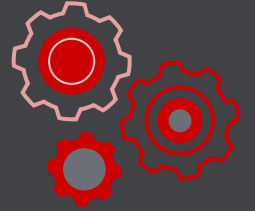
03



DESIGN DECISIONS & IMPLEMENTATION



HARDWARE



SBC ANALYSIS

PROCESSING POWER

Single Board Computer	CPU Clock Frequency (MHz)	GPU Clock Frequency (MHz)
Arduino Nano 33 BLE Sense	64 MHz	N/A
Asus Tinker Board S	1800 MHz	600 MHz
NVIDIA Jetson Nano	1430 MHz	640 MHz
Raspberry Pi 4 Model B	1500 MHz	N/A

ENERGY CONSUMPTION

Single Board Computer	Operating Voltage (V)	DC Current Min - Max (mA)	Power Consumption Min - Max (mW)
Arduino Nano 33 BLE Sense	3.3V	15 - 330 mA	49.5 - 1089 mW
Asus Tinker Board S	5 V	500 - 1000 mA	2500 - 5000 mW
NVIDIA Jetson Nano	5 V	1000 - 2000 mA	5000 - 10000 mW
Raspberry Pi 4 Model B	5 V	540 - 1280 mA	2700 - 6400 mW

MEMORY SIZE

Single Board Computer	Memory (GB)
Arduino Nano 33 BLE Sense	0.001 GB FLASH 0.000256 GB SRAM
Asus Tinker Board S	2GB Dual Channel DDR3
NVIDIA Jetson Nano	2 GB LPDDR4
Raspberry Pi 4 Model B	2 GB LPDDR4

COST ANALYSIS

Single Board Computer	Board Price (\$)	Percentage of System Cost (%)
Arduino Nano 33 BLE Sense	\$22.50	4.5%
Asus Tinker Board S	\$199.99	40%
NVIDIA Jetson Nano	\$62.84	12.6%
Raspberry Pi 4 Model B	\$83.95	16.9%



SINGLE-BOARD COMPUTER (SBC)

FEATURES

Powerful GPU in a compact form factor

OVERALL VALUE

Great Value Proposition



WEALTH OF KNOWLEDGE

Extensive Developer Community and Resources

COSTS

Cheaper than comparable alternatives

JETSON NANO

SPECIFICATIONS

	ATmega2560	MSP430BT5190	MSP430FR698x	MSP430F249
Architecture	8-bit RISC	16-bit RISC	16-bit RISC	16-bit RISC
Clock Speed	16 MHz	25 MHz	16 MHz	16 MHz
Voltage Range	2.7V – 5.5V	1.8V – 3.6V	1.8V – 3.6V	1.8V – 3.6V
Active Power Mode	500 μ A	230 μ A/MHz	100 μ A/MHz	270 μ A/MHz
Standby Power Mode	11.85 mA	1.2 μ A	0.4 μ A	0.3 μ A
Wake Time from Sleep/LP Mode	Unknown	< 5 μ s	6 μ s	< 1 μ s
Non-Volatile Memory (kB)	256	256	128	60
RAM (kB)	8	16	2	2
UART	4	0	2	2
I2C	1	4	2	2
SPI	1	4	4	2
Bluetooth Version	N/A	2.1	N/A	N/A

PROJECT CONTROLLER ANALYSIS

Part	Communication Scheme
Accelerometer	I2C
SD Card	SPI*
Bluetooth	UART, I2C, or SPI*
GPS (Stretch Goal)	UART
Single Board Computer	SPI
* - can use the same pin for both connected in an SPI daisy-chain configuration	



METHOD OF COMMUNICATION

PROJECT CONTROLLER

TI MSP430FR6989

CONVENIENCE

Familiar and
Previously
Acquired



CAPABLE

Enough channels
to run all
communications

ACCELEROMETER

MEMSIC MXC4005XC-B

IMPACT SURVIVAL

Maximum
Acceleration
200,000g

TINY FOOTPRINT

6 solder pads
0.25mm wide each
underneath chip



INTERRUPTS

Shake Detection

SOLUTION

Breakout board
will plug directly
into PCB

CAMERA

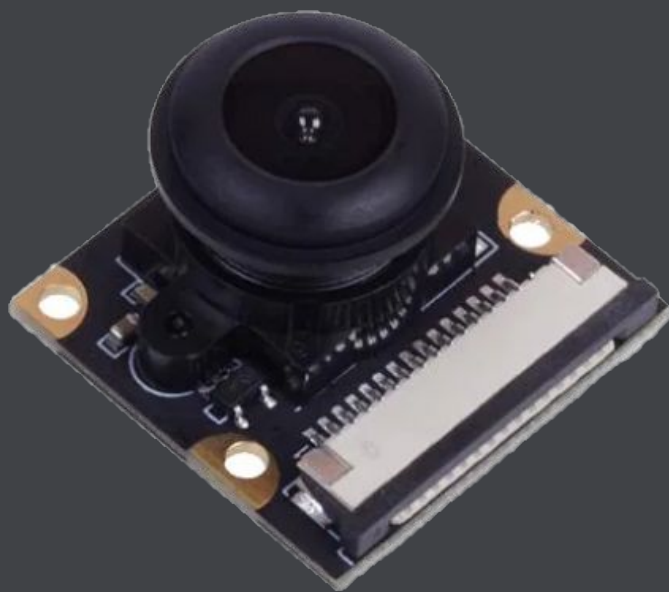
SEED STUDIO 114992262

8 MEGAPIXELS

Exceeds 1080p
Requirements

130° FIELD OF VIEW

Allows for little
distortion



MADE FOR US

Designed
specifically to
interface with
Jetson

STORAGE UNIT

MORE PERMANENT

Less risk of data loss than BT

PORTABILITY

Can be removed and read in any device that can access uSD Card



MICRO SD CARD

RELIABLE

Shown to consistently store .txt files

EASILY ACCESSIBLE

Large variety of uSD Card compatible with FatFs Library

BLUETOOTH

RAYTAC MDBT42Q-P192

AVAILABILITY

Readily available on many online retailers

USER SUPPORT

Plenty of examples to work with



BLUETOOTH 5.0

Fits our Bluetooth 5.0 requirement

EASILY PROGRAMMABLE

J-Link via Nordic Dev Kit

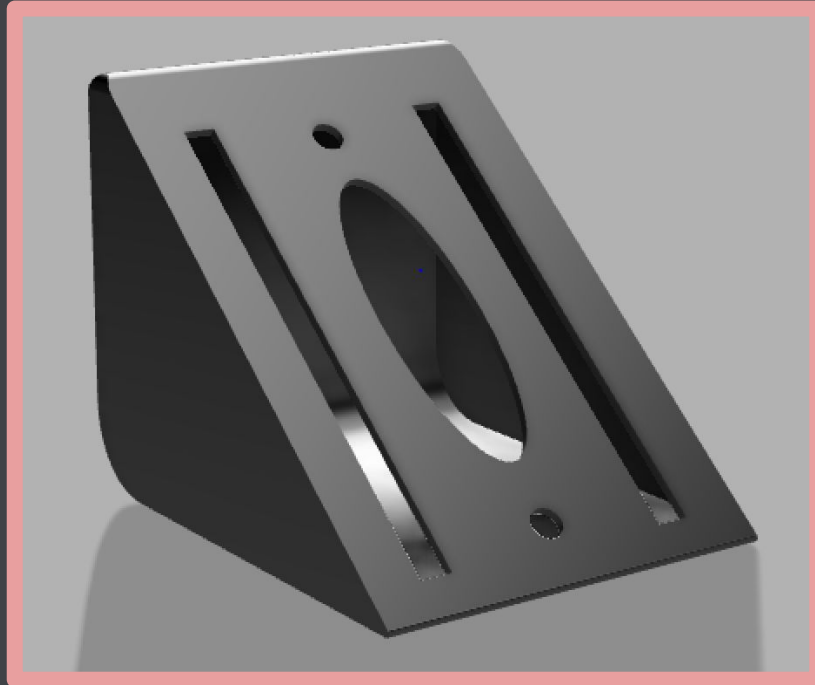
ENCLOSURE

3D PRINTED

ABS Filament for added strength

ACETONE VAPOR POLISHING

Added strength and temperature tolerance



PCB SLIDE SHELVING

PCB will slide and lock into place

HIGH GRADE SUCTION CUPS

Affixed to Windshield

BATTERY

MAKERFOCUS 9065115

LITHIUM POLYMER

Low Self-Discharge
Resilient to High
Temperatures

PROTECTION CIRCUIT MODULE

Thermal Protection
Overcurrent Protection
Short-Circuit Protection



HIGH CAPACITY

10,000 mAh
74 Wh = 5.6 Hrs of
CSS operation

STANDARD ADHERENCE

IEEE 1725-2021
IEC/UL 62133

5 VOLT REGULATOR

TEXAS INSTRUMENTS LM3150

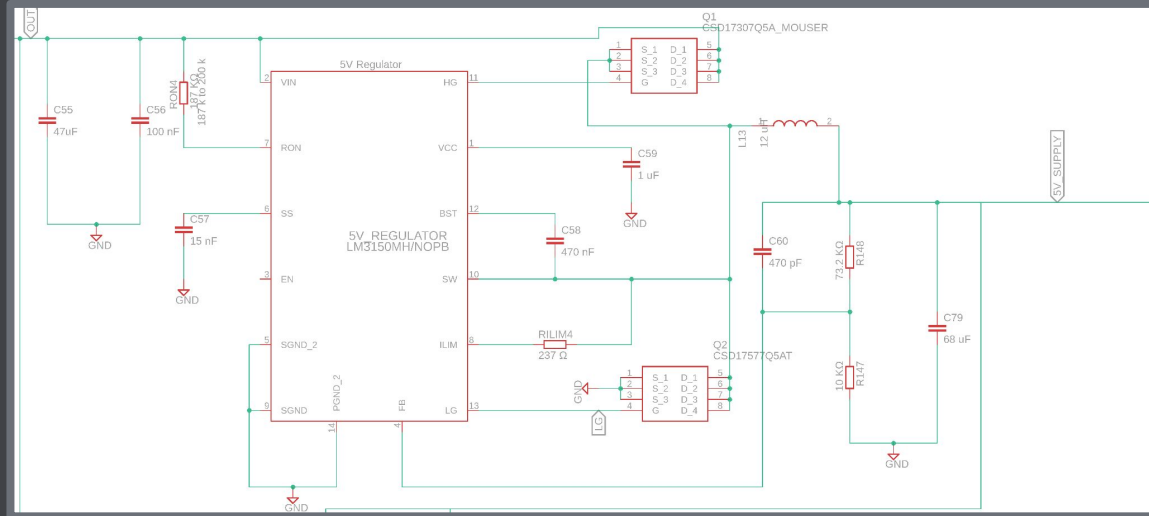
HIGH EFFICIENCY

96.3%

Drives high efficiency external MOSFETs

OVERCURRENT PROTECTION

Feedback network monitors current



LOW COST

Only 61% cost of comparably efficient topologies

ADDITIONAL PROTECTION

Short Circuit
Soft Start
Thermal

3.3 VOLT REGULATOR

TEXAS INSTRUMENTS TLV62568

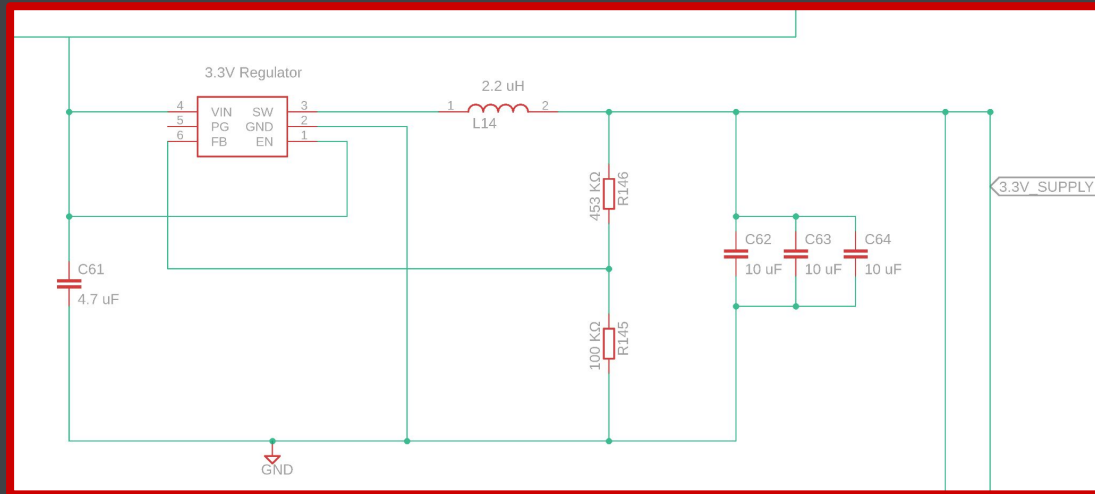
HIGH EFFICIENCY

96.26 %

With Minimal
PCB Area and Cost

OVERCURRENT PROTECTION

Integral current
detection with auto
shut-off and restart



SOFT START

Limits dV/dT to
protect sensitive
downstream
devices

DYNAMIC FREQUENCY

Provides additional
efficiency under
low load

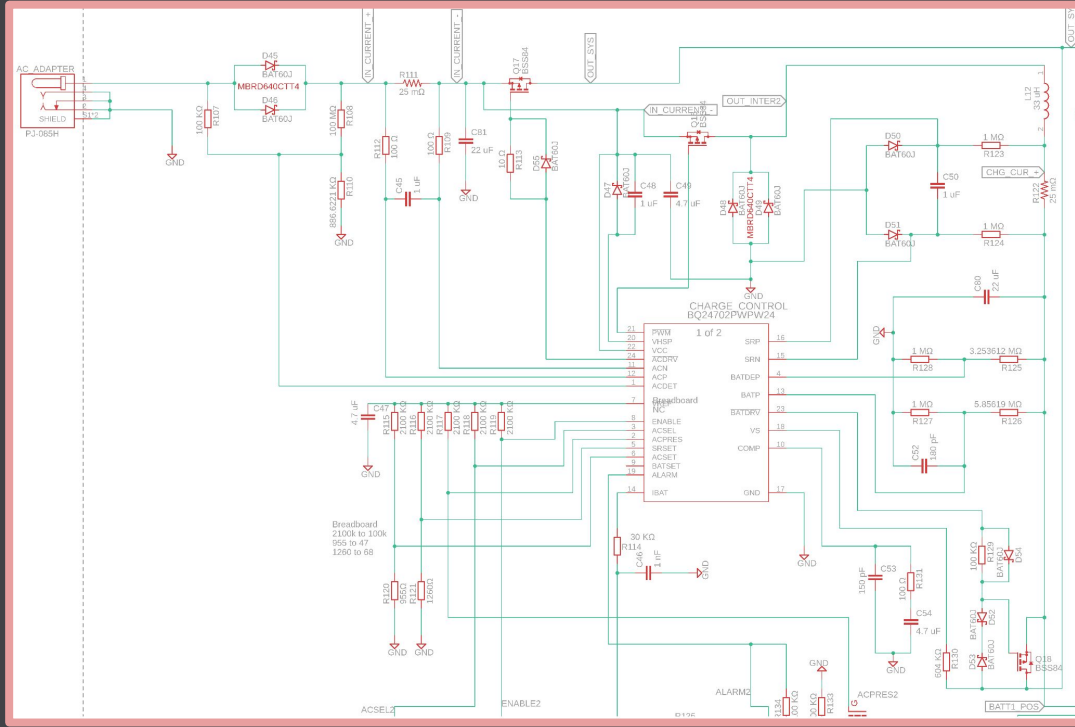
CHARGE CONTROLLER

HIGH EFFICIENCY

Low quiescent power consumption when on battery power

CONCURRENT LOAD/CHARGE

Provides system power from AC while simultaneously charging the batteries



DYNAMIC SOURCE SWITCHING

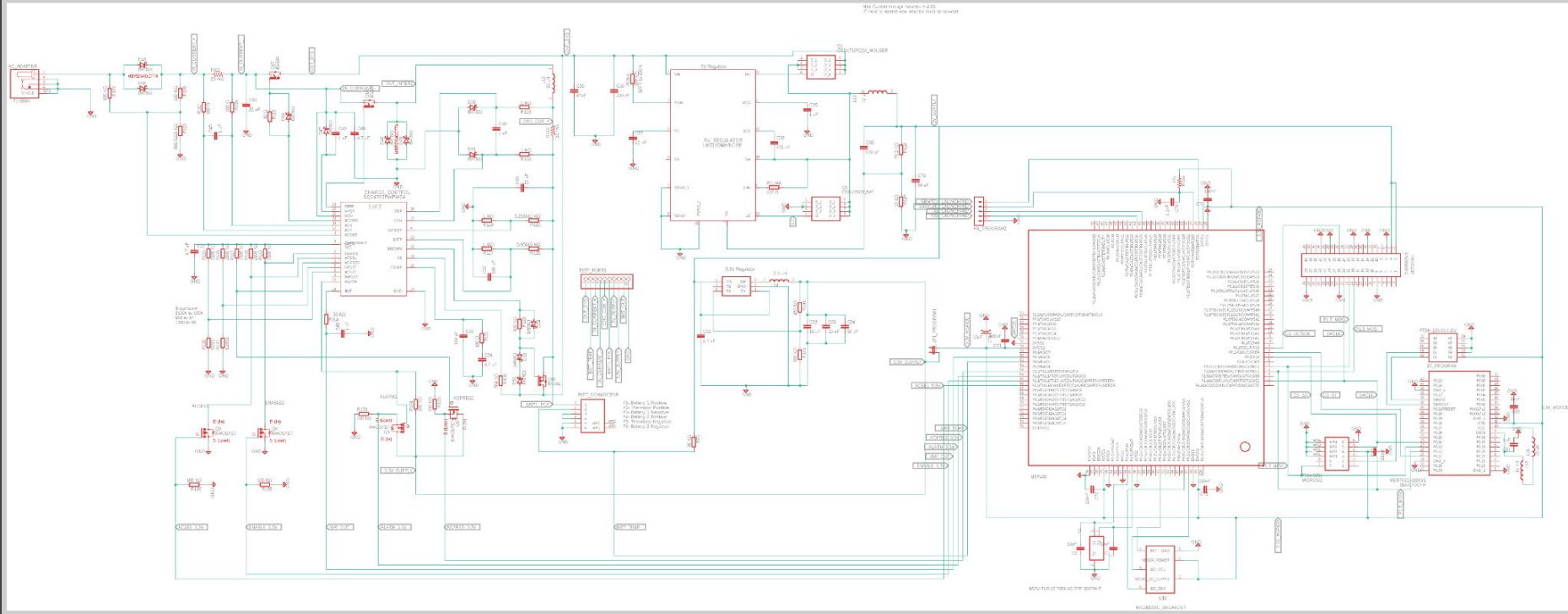
Seamlessly changes from AC supply to battery supply without interruption

PROTECTION

Overcurrent
Undervoltage
Thermal
Short Circuit

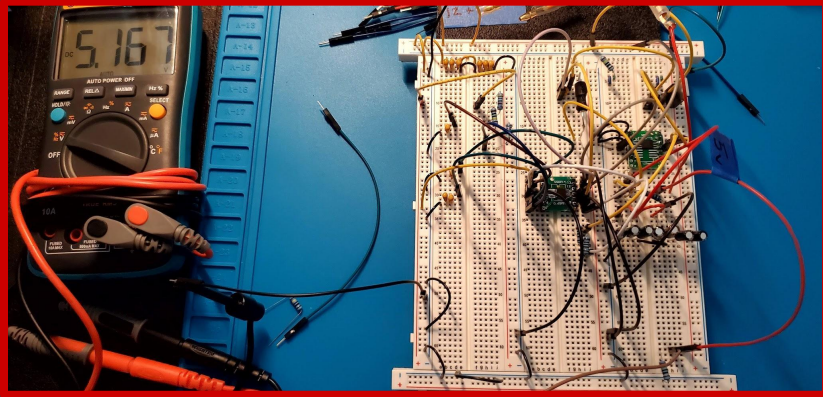
TEXAS INSTRUMENTS BQ24702

INTEGRATED SCHEMATIC

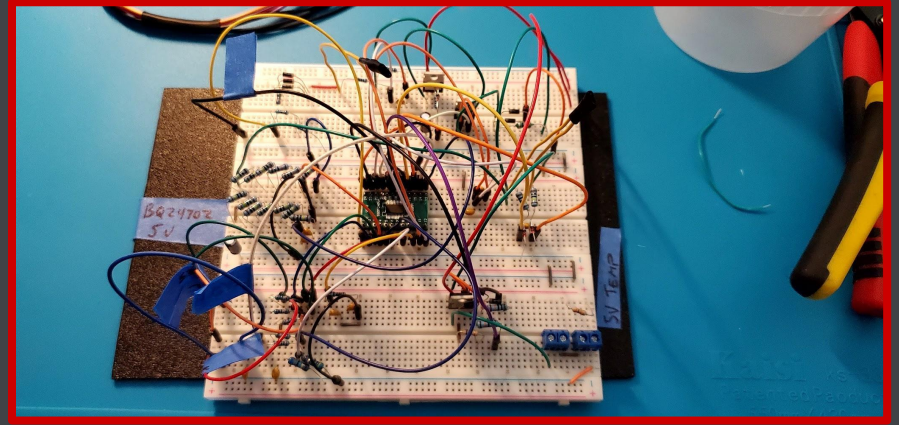


PCB PROTOTYPING

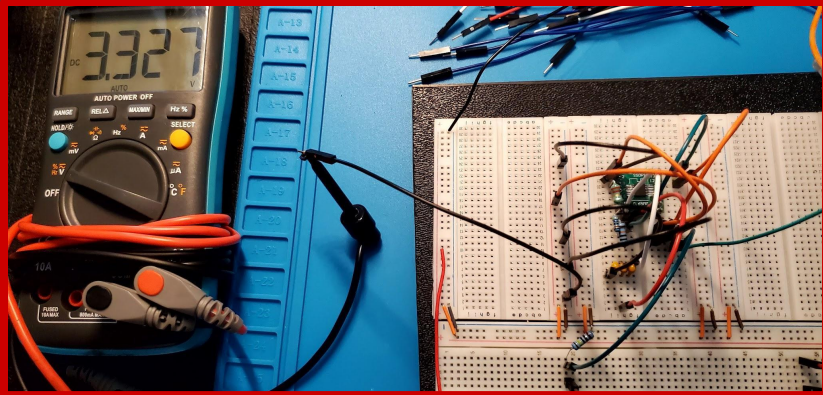
5 VOLT RAIL

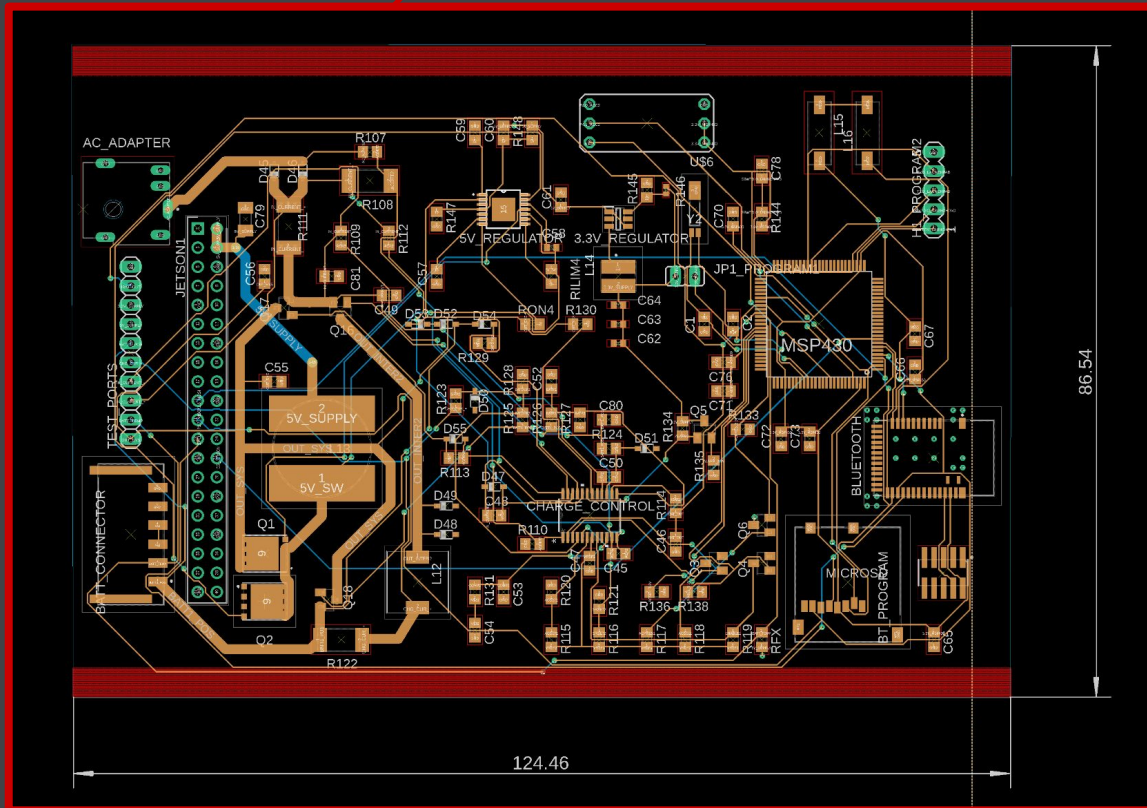


CHARGE CONTROLLER



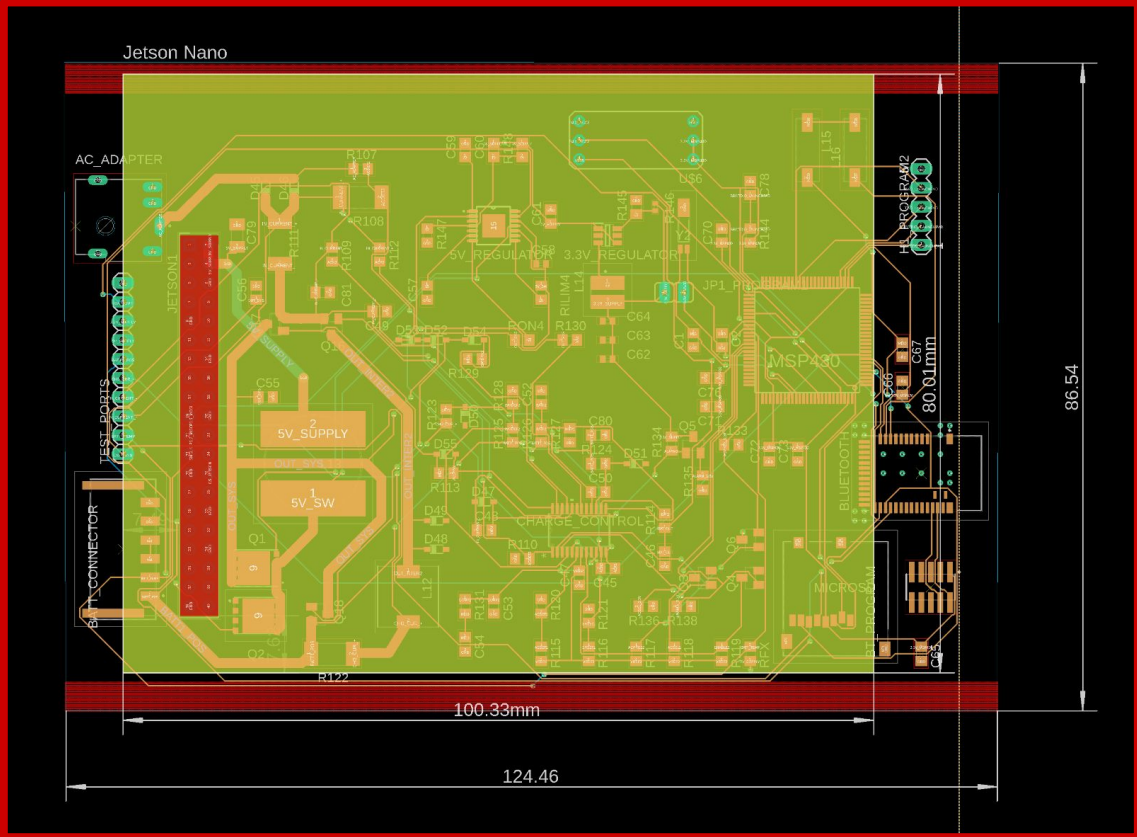
3.3 VOLT RAIL





PCB LAYOUT

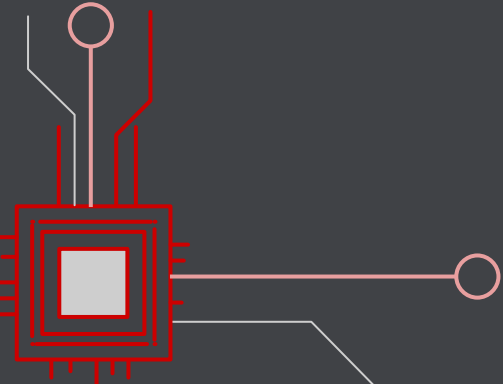
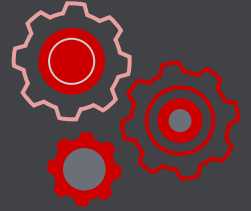




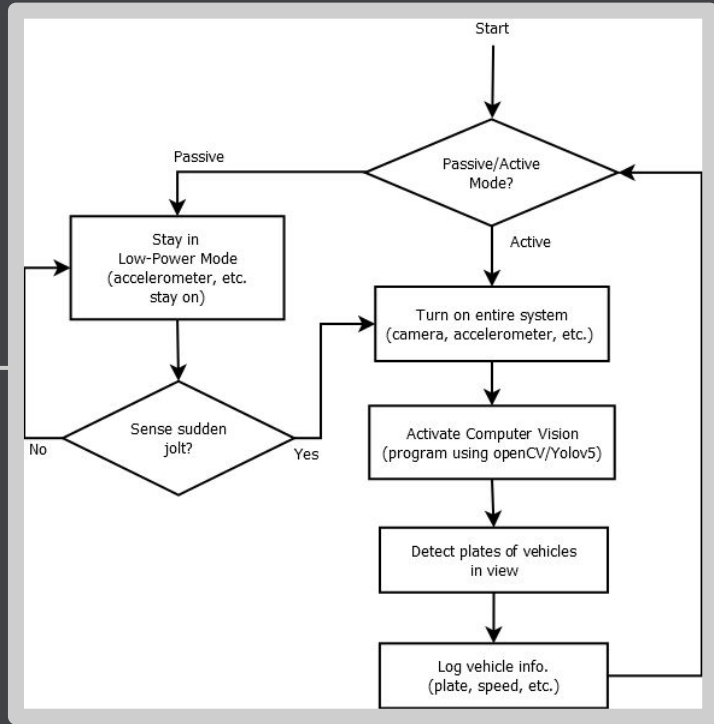
PCB LAYOUT WITH NVIDIA JETSON NANO



SOFTWARE/FIRMWARE



SINGLE BOARD COMPUTER SOFTWARE FLOW





COMPUTER VISION

OPENCV

Easy to get up and running
Used for testing purposes

OPENCV

Powerful pretrained algorithms

OPTICAL CHARACTER RECOGNITION (OCR)

To recognize characters

OBJECT DETECTION

Identify and isolate license plate area

TENSORRT

Used for training
Optimized for Nvidia GPUs

EDGE DETECTION

To isolate characters



GRAPHICAL USER INTERFACE & FEATURES



Users are able to create their own accounts and access License Plate data.

Stretch Goal: Optional attributes can be stored, such as color, make, and model.

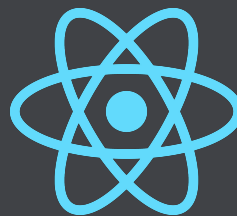
MOBILE APPLICATION DEVELOPMENT

- Progressive Web Application (PWA)
- FERN Stack

FERN STACK

FIREBASE

Robust and
scalable database
system



REACT

Team members have
experience with
REACT frontend dev.

EXPRESS

Framework for
APIs

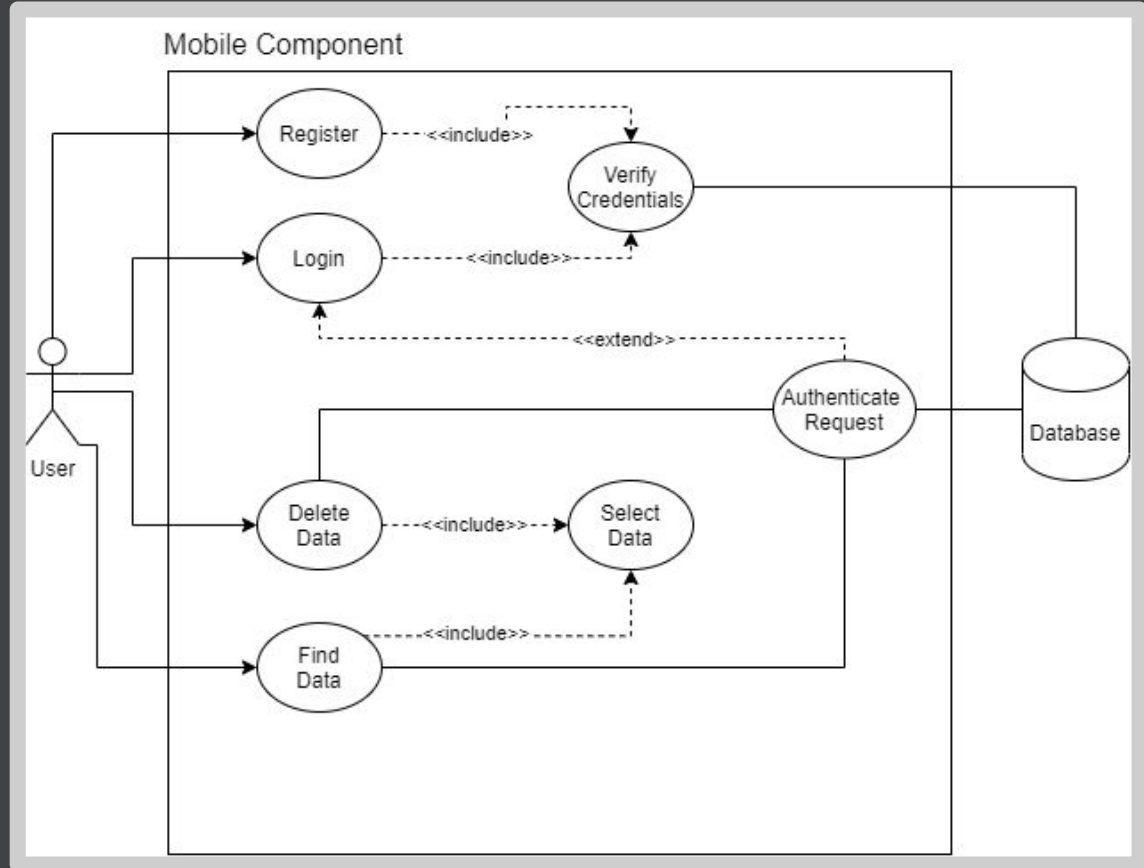


NODE.JS

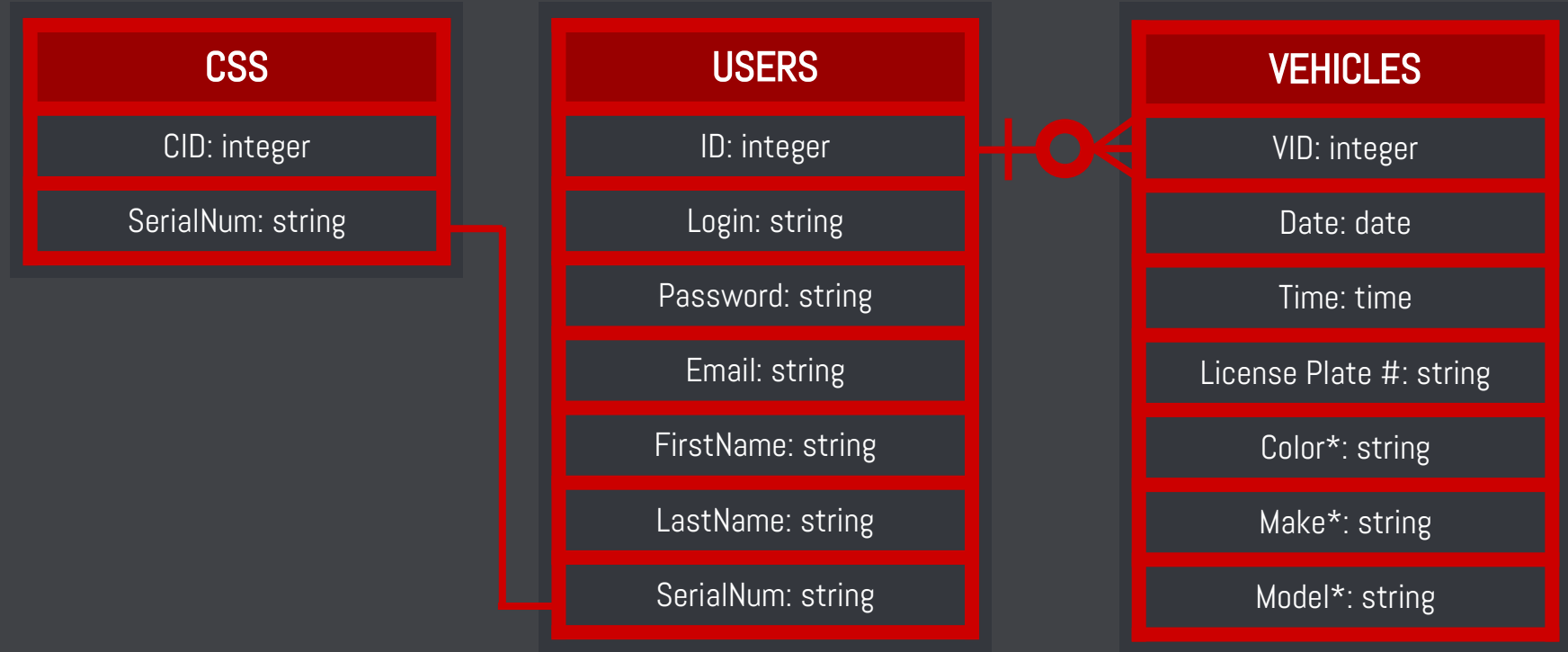
Backend
environment

Tried and true technology stack.
Facilitates faster development

MOBILE APPLICATION USE CASE DIAGRAM

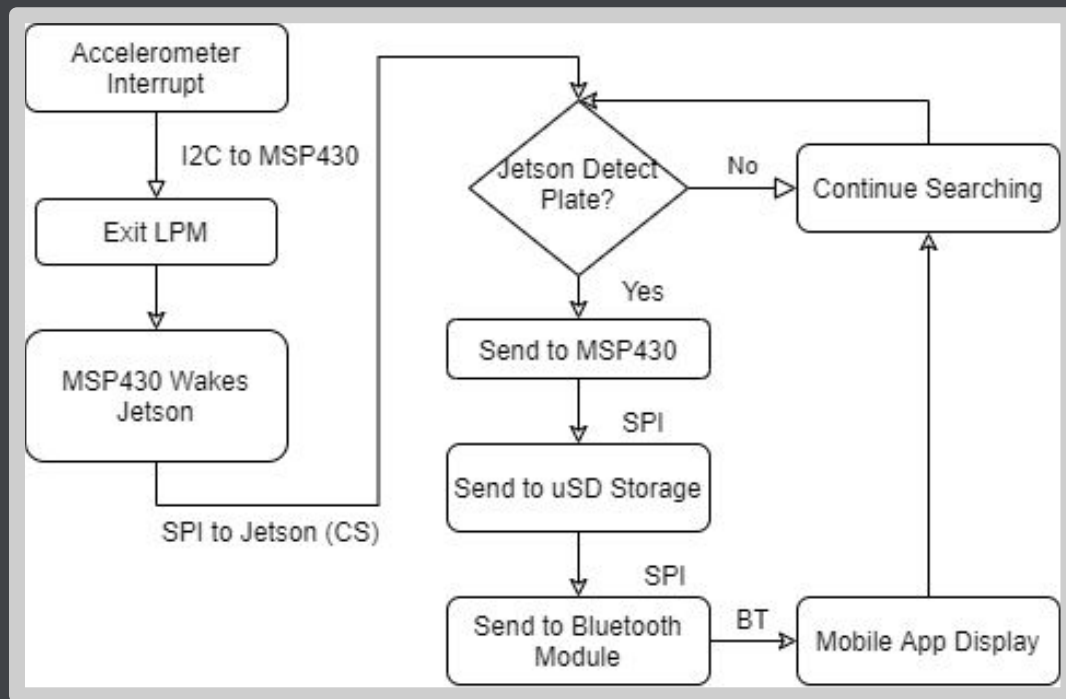


ENTITY RELATIONSHIP DIAGRAM



* Stretch Goal

FIRMWARE DATAFLOW



FIRMWARE DEVELOPMENT



Visual Studio Code

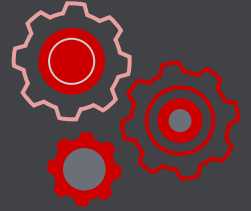


TI CODE
COMPOSER
STUDIO

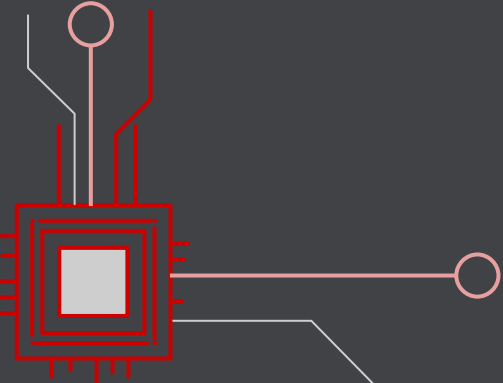
NORDIC[®]
SEMICONDUCTOR



04



EXPERIENCE





SUCCESSSES

- Getting the Nano to read a license plate
- MSP430FR6989 writing .txt files to uSD card on breadboard
- Raytac BT module programmable
- Breadboarding sensitive switching circuits

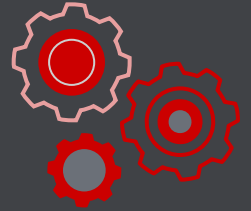
CHALLENGES

- Tackling CV/ML
- Data transmission across all components
- Specced some parts too small to solder by hand
- Nordic Software Bugs

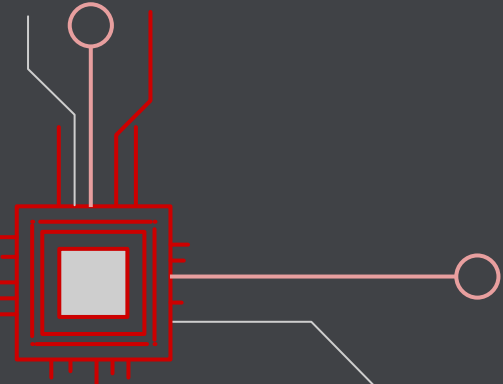




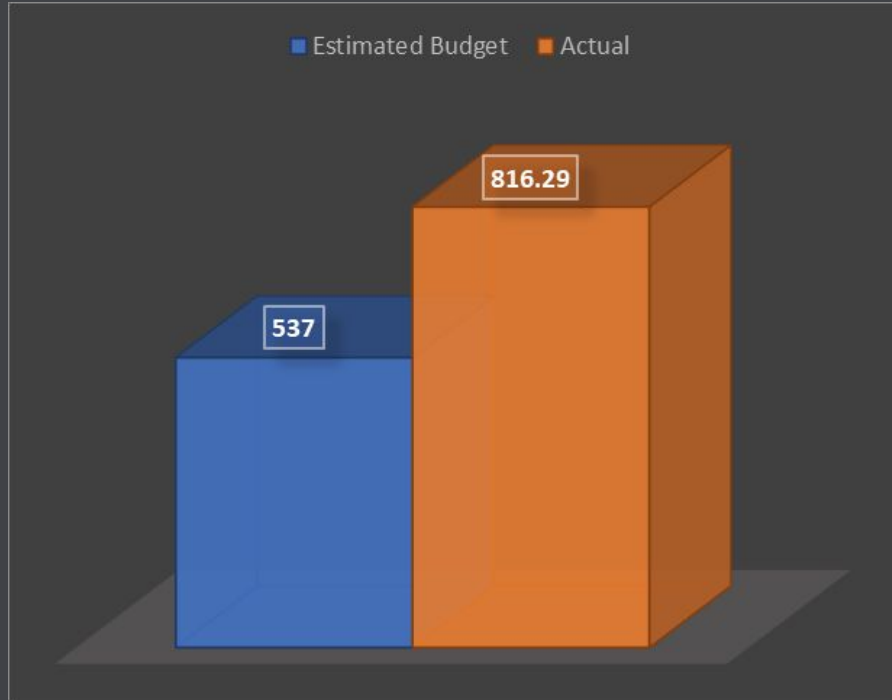
05



ADMINISTRATION



BUDGET & FINANCING



**BOUGHT TWO JETSON NANO DEV.
KITS FOR TESTING**

**MISC COMPONENTS WERE
ANOTHER MAJOR EXPENSE**

PCB ORDER APPROX. \$130



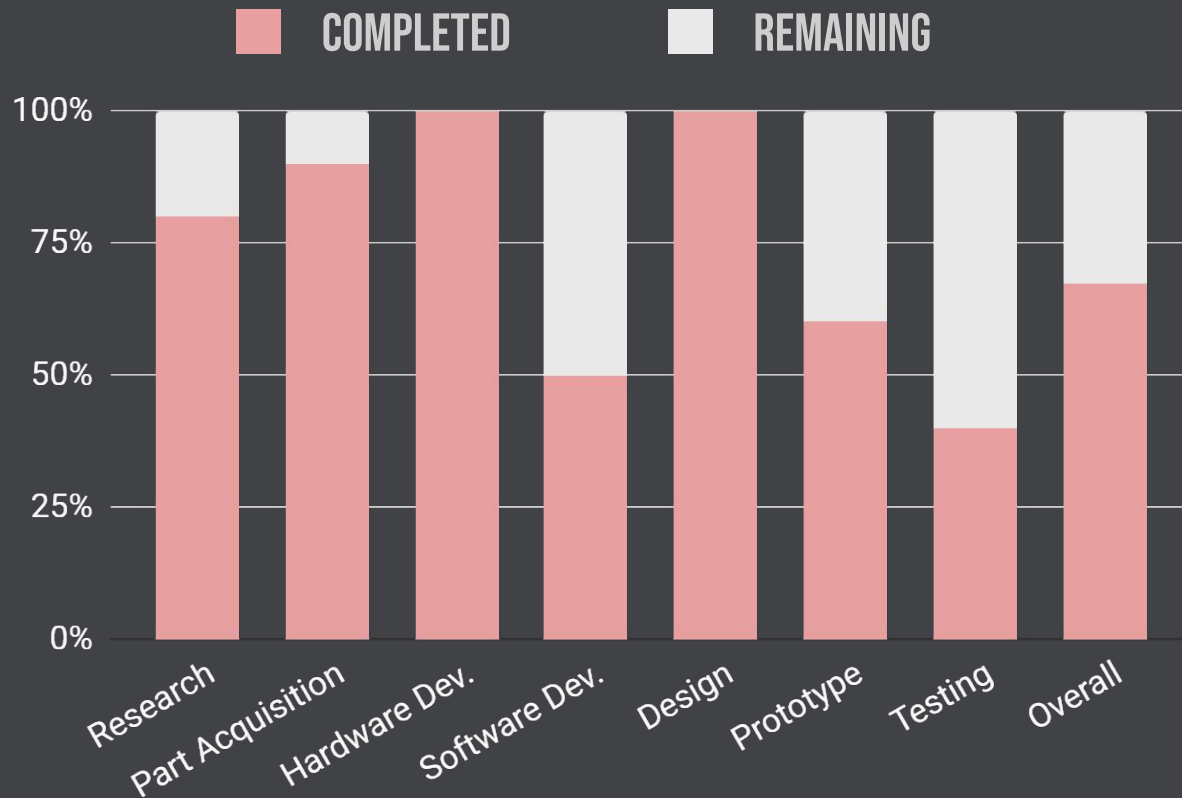
Item	Price	Quantity	Shipping Cost	FL Tax	Total
MSP430FR6989	\$10.10	2	-	1.07	\$29.50
NVIDIA Jetson Nano	\$59.00	1	-	1.065	\$62.84
5V 4A Power Supply	\$12.59	2	-	1.065	\$26.82
2.5 to 2.1mm Adapter	\$8.96	2	-	1.065	\$19.08
4GB NVIDIA Jetson Nano	\$169.95	1	-	1.065	\$181.00
GY-521 MPU-6050 MPU6050 Module 3 Axis analog gyro sensors	\$2.64	1	-	1.00	\$2.64
WAVGAT Micro SD Storage Expansion Board	\$1.83	1	-	1.00	\$1.83
Accelerometer & uSD expansion	\$3.25	1	-	1.00	\$3.25
10000mAh LiPo Batteries	\$12.00	2	-	1.00	\$24.00
Cooling Unit	\$24.38	2	\$1.50	1.00	\$50.26
uSD Module	\$0.20	1	\$1.80	1.00	\$2.00
GPS Module	\$2.60	1	\$1.65	1.00	\$4.25
Camera Module	\$19.90	1	-	1.07	\$21.29
Accelerometers	\$1.49	2	-	1.07	\$3.19
Mouser Shipping	\$7.99	1	-	1.00	\$7.99
10000mAh LiPo Battery	\$13.82	2	\$0.99	1.07	\$30.56
BL651/BL652 Breakout PCB	\$8.00	2	\$9.98	1.065	\$27.02

COST OF COMPONENTS

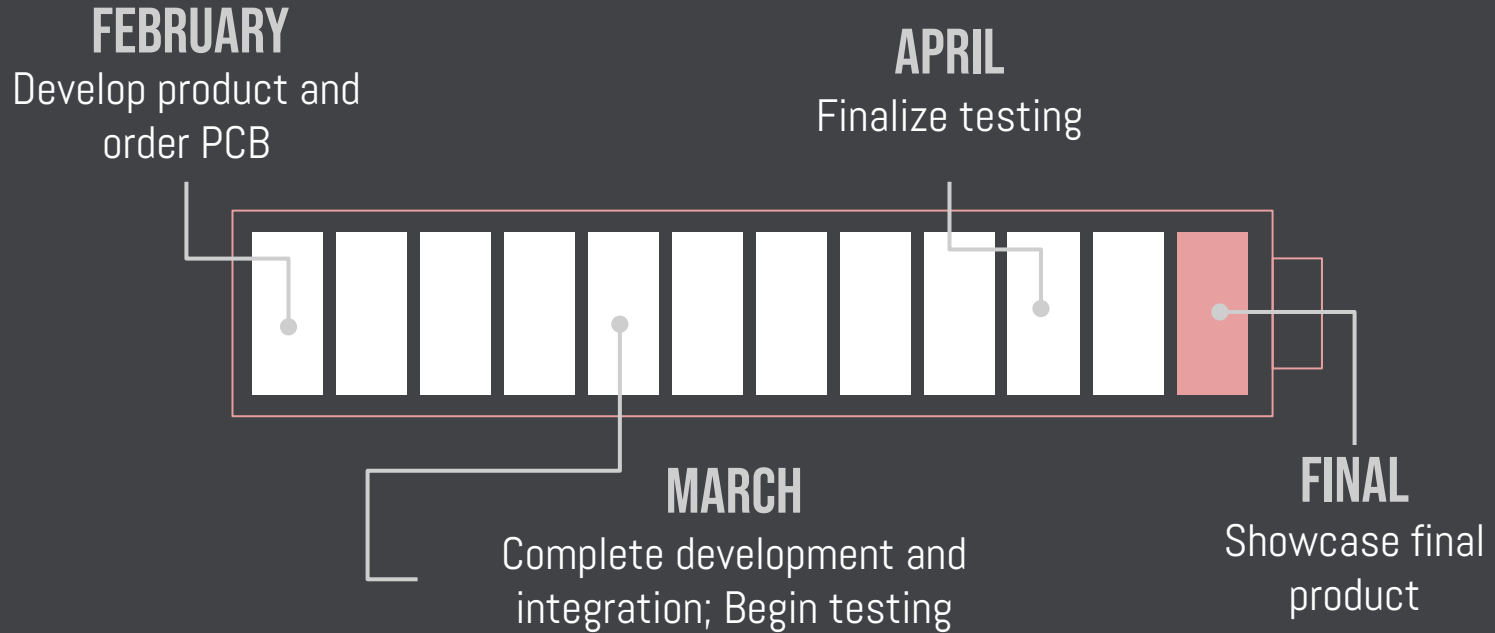
WORK DISTRIBUTION

	ROLES	RESPONSIBILITY
QRIZELLE C.	Lead Mobile Developer	Computer Vision and Mobile Application
RICARDO N.	Lead Computer Vision Developer	Computer Vision and Mobile Application
ARI P.	Lead Firmware Developer	Hardware (PCB) and Firmware Development
ROBERT Z.	Lead Power Systems Engineer	Hardware (PCB) and Schematic Integration

PROGRESS



IMMEDIATE PLANS





QUESTIONS?