



ENSC 440W/305W

PROJECT GROUP B

Monday December 14th, 2015

Solarity by SUNLINK



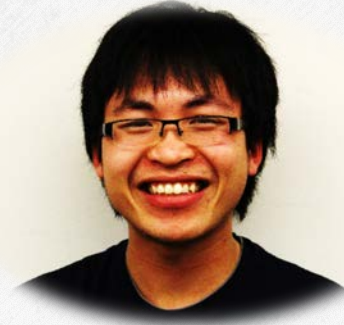
THE TEAM



Zach Kaarvik
CEO



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COO



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CTO



Dejan Jovasevic
CFO

OUTLINE

AT A GLANCE

01 Overview

02 Hardware

03 Software

04 Mechanical

05 Business Aspects

06 Reflection

07 Questions

08 Demo



OVERVIEW

BACKGROUND



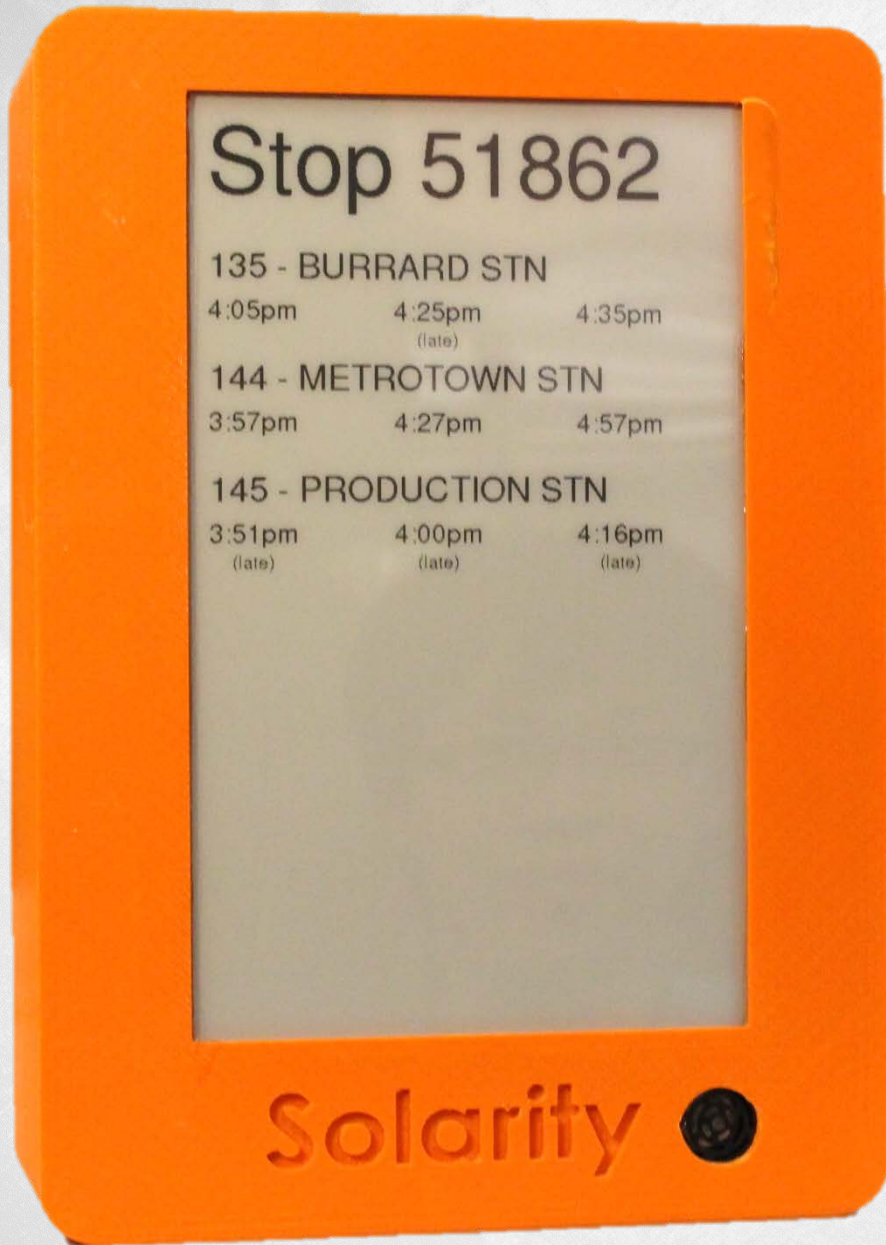
- 418,000 people take transit a day (2014)
- Traffic and unexpected circumstances lead to late buses
- How can we make it easier for them?

MOTIVATION

- We are regular Transit Users
- Translink App does not accommodate everyone
- Improve current paper schedules

OUR GOAL

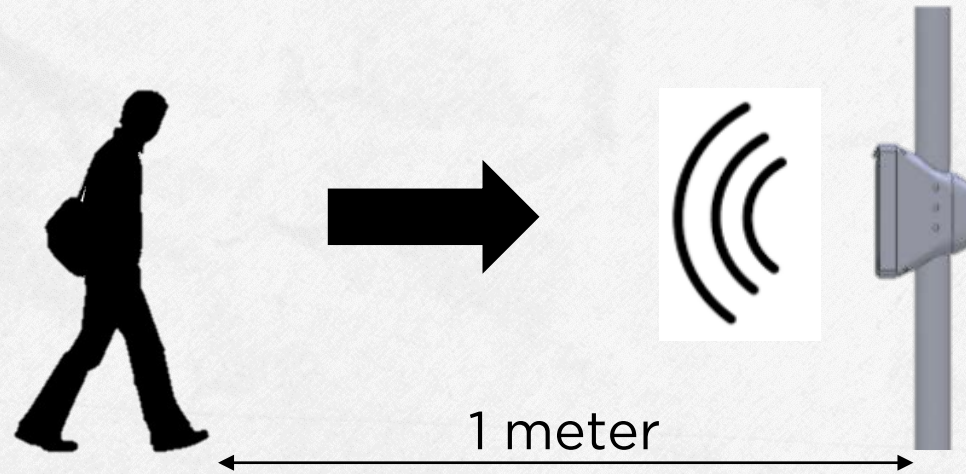
- To build a device that provides real-time info to transit users
- Have a cost-effective solution
- Power with solar energy to minimize costs and be powered wirelessly



**“SELF
SUSTAINING
REAL-TIME
BUS
DISPLAY”**

SOLARITY INTERACTIONS

Preliminary Step: User arrives at transit stop which is equipped with Solarity device.

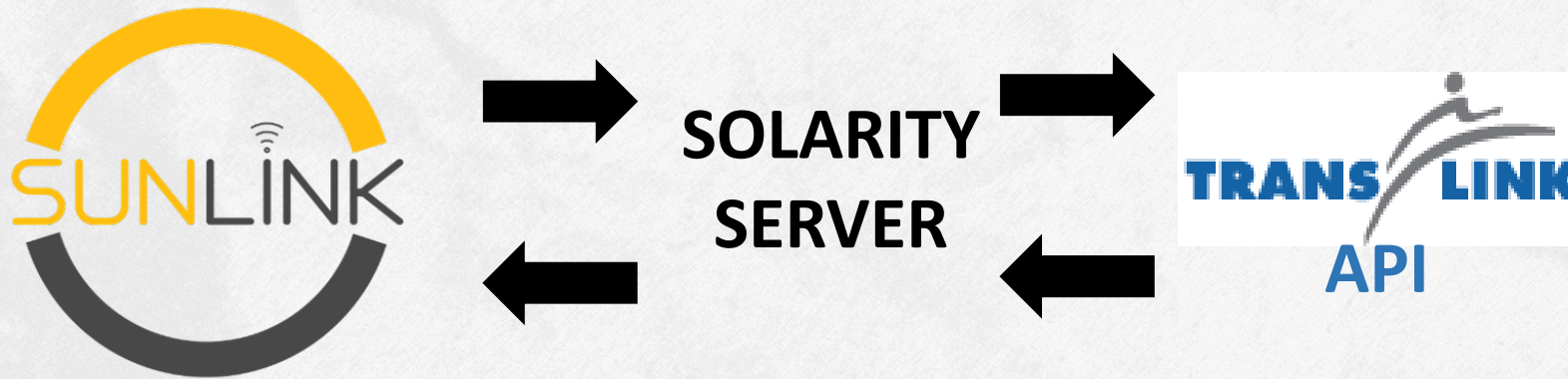


- Proximity sensor detects nearby transit user

SOLARITY INTERACTIONS

CONT'D

Step 2: Solarity System sends request to server



- Retrieves data from Translink open API
- Data contains bus times for particular stop

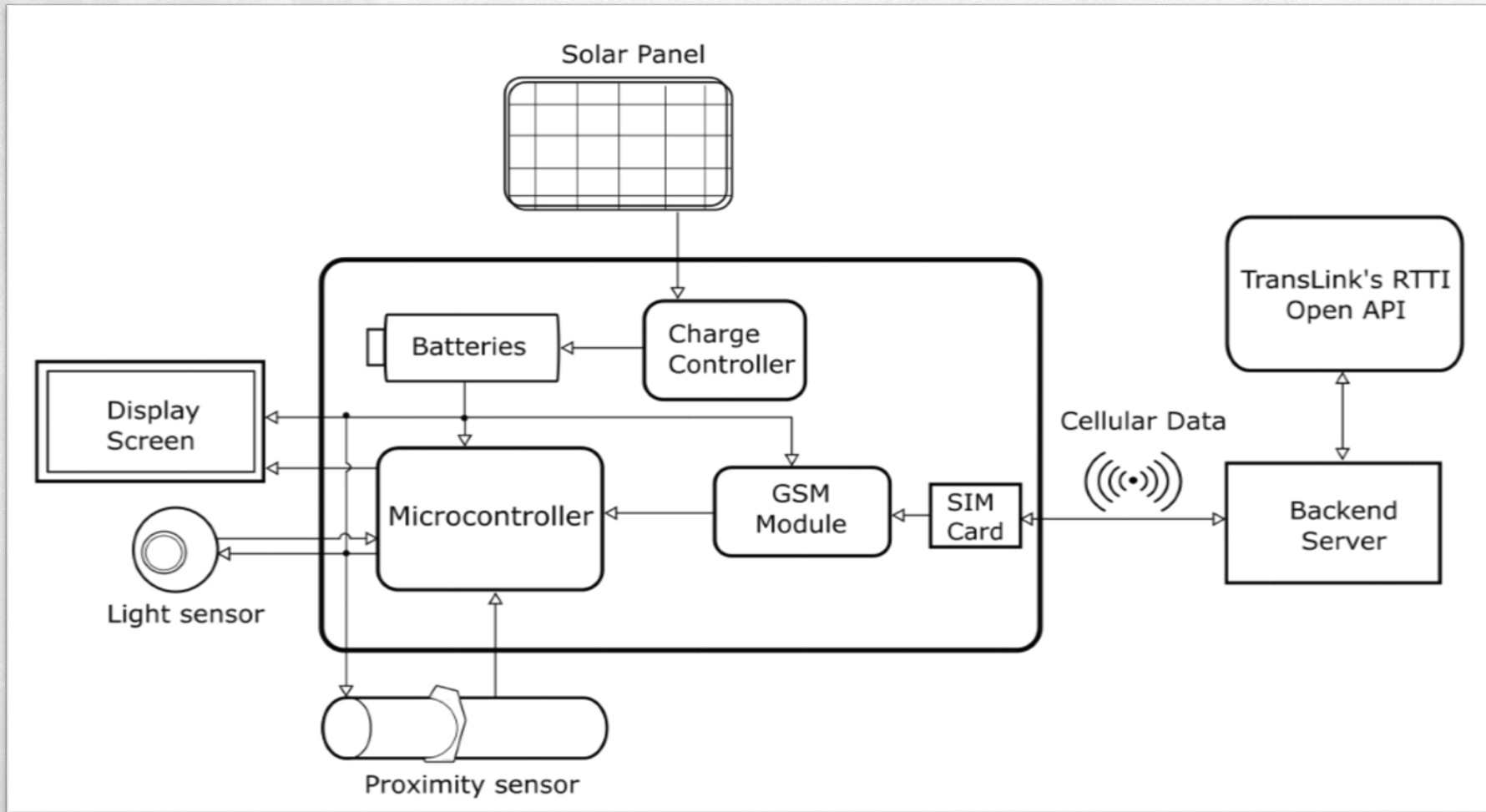
SOLARITY INTERACTIONS

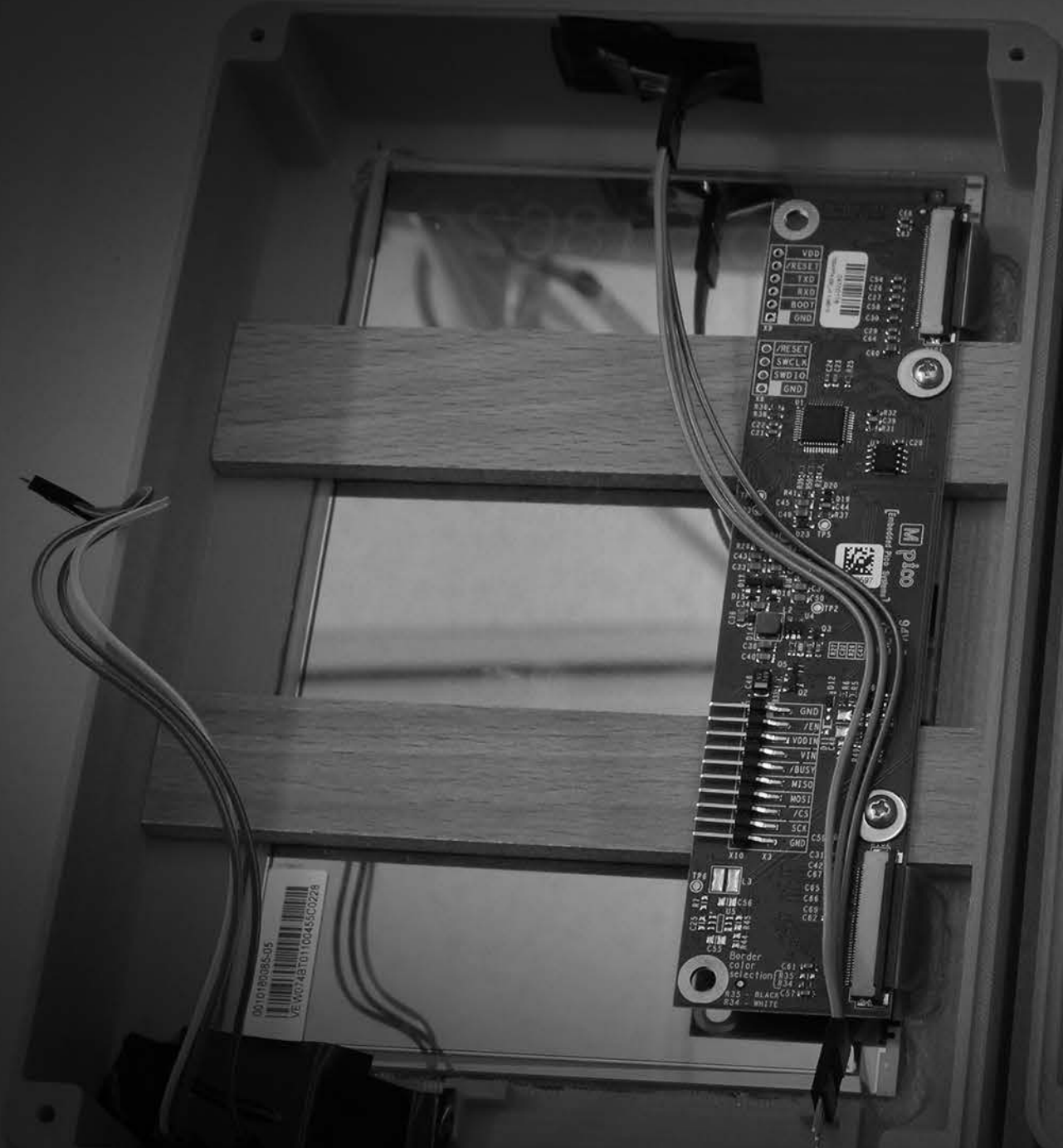
CONT'D

Step 3:

- The Display will refresh with updated transit times.
- Users can make their decisions based on real-time info

SYSTEM OVERVIEW





HARDWARE

MICROCONTROLLER – MSP432

- MSP432P401R
- Ultra-Low Power Operating Modes
- Inexpensive
- Serial SPI/UART communication



DISPLAY – MPICO 7.4"

PERVASIVE DISPLAY

- E-INK
- Bistable: retains image when not powered
- Consumes power only when updating



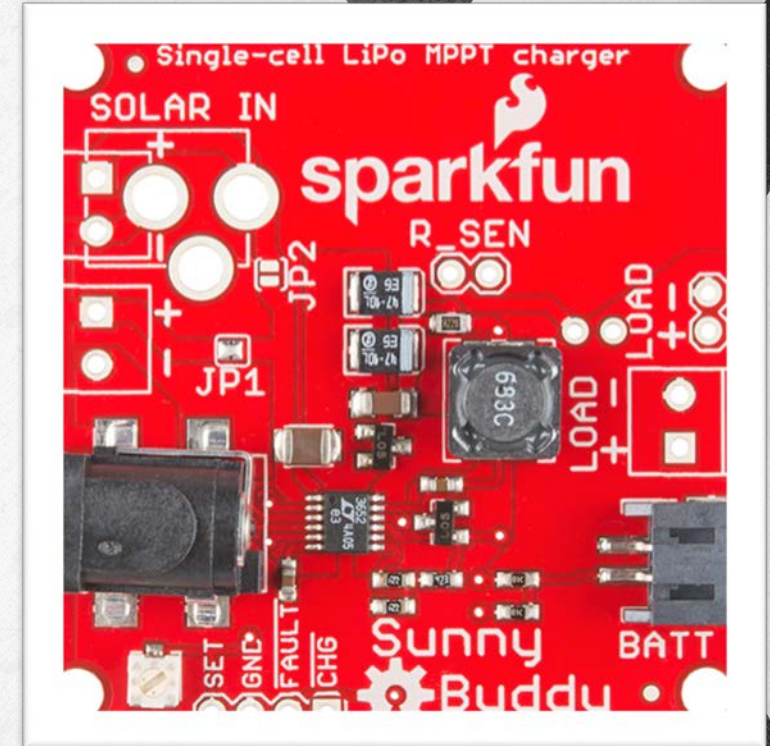
PROXIMITY SENSOR

- LV-MaxSonar-EZ0
- Ultrasonic sensor
- Better for outdoor conditions
- Low power (2mA)
- Wide and sensitive beam pattern



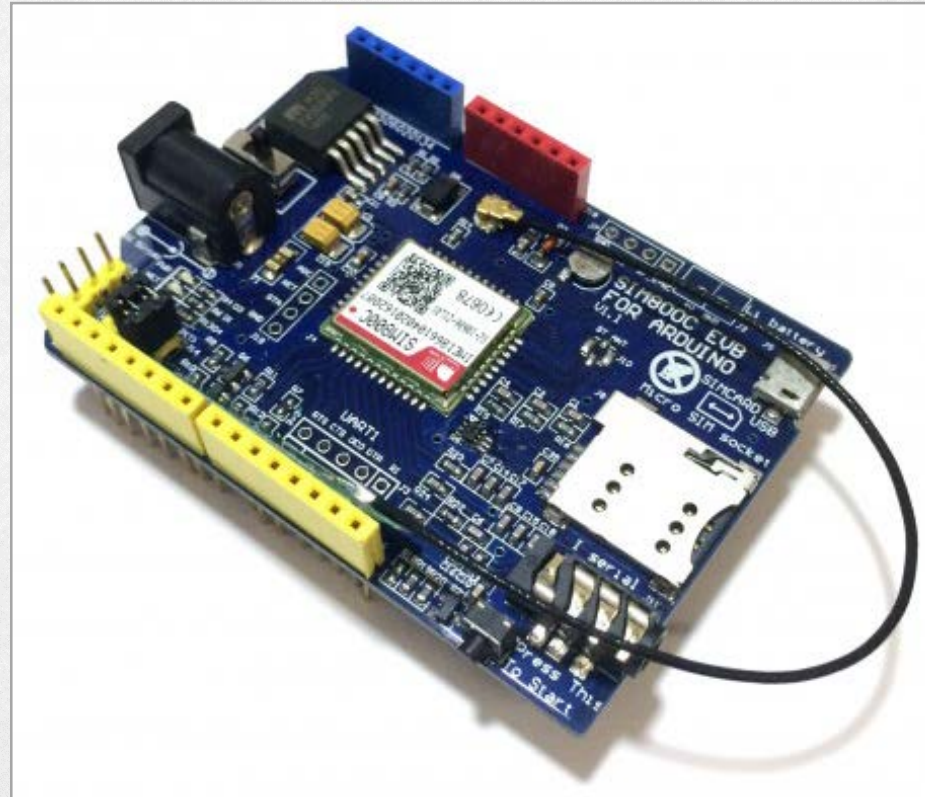
CHARGE CONTROLLER

- Sunny Buddy - MPPT Solar Charger
- Maximum Power Point Tracking (MPPT)
- Switching mode operation
- Maximum charge current of 1A



GSM MODULE- SIM800c

- Compact
- Supports 2G/3G networks



POWER

- Total power: 5.1 Wh/day
- Lowest monthly solar energy in Vancouver is 810Wh/m²/day [6]
- 30cm * 20cm is approximate required size



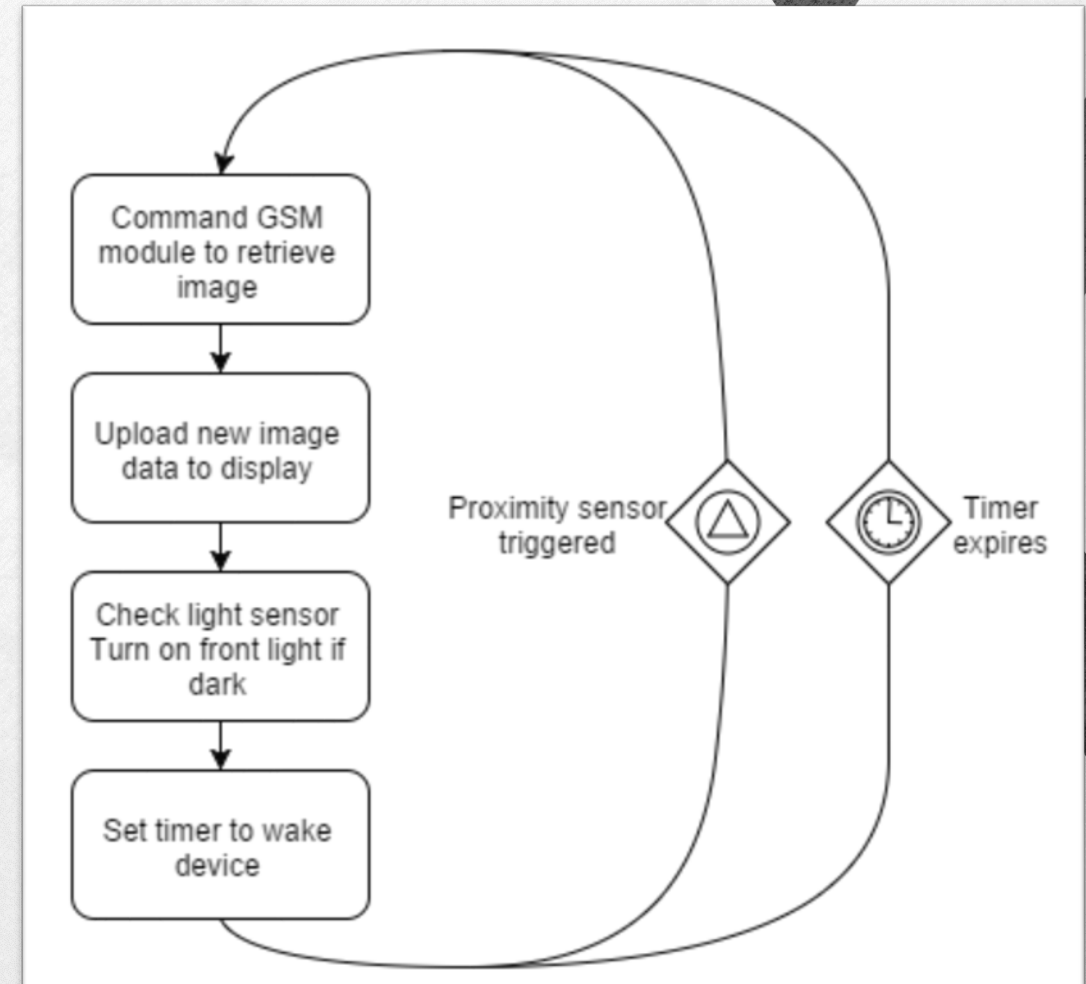


```
Database.php x app.php x autoload.php x kernel.php x cache.php x auth.p
17 query->shouldReceive('where')->once()-with('taggable_id', 1)-andReturn($query);
18 query->shouldReceive('where')->once()-with('taggable_type')->andReturn($query);
19 query->shouldReceive('where')->once()-with('tag_id', array(1, 2, 3))-andReturn($query);
20 query->shouldReceive('delete')->once()-andReturn(true);
21 MockBuilder->shouldReceive('getQuery')->andReturn($mockQueryBuilder = m::mock('StdClass'));
22 $relation->expects($this->once())->method('touchIfTouching');
23
24 $this->assertTrue($relation->detach(array(1, 2, 3)));
25
26 public function testDetachMethodCallsEloquentRecordsInOrder()
27 {
28     $relation = $this->getMock('IlluminateDatabase\EloquentRelations\MorphToMany', array('touchIfTouching'),
29     $query = m::mock('StdClass');
30     $query->shouldReceive('from')->once()-with('taggables')->andReturn($query);
31     $query->shouldReceive('where')->once()-with('taggable_id', 1)-andReturn($query);
32     $query->shouldReceive('where')->once()-with('taggable_type', get_class($relation->getParent()))->andReturn($query);
33     $relation->shouldReceive('delete')->once()-andReturn(true);
34     $relation->shouldReceive('getQuery')->andReturn($mockQueryBuilder);
35     $relation->expects($this->once())->method('touchIfTouching');
36     $relation->expects($this->once())->method('touchIfTouching');
37     $this->assertTrue($relation->detach());
38 }
39
40 public function getRelation()
41 {
42     list($builder, $parent) = $this->getRelationArguments();
43     return new MorphToMany($builder, $parent, 'taggable', 'taggables', 'taggable_id', 'tag_id');
44 }
45
46 public function getRelationArguments()
47 {
48     $parent = m::mock('IlluminateDatabase\Eloquent\Model');
49     $parent->shouldReceive('getOriginalClass')->andReturn(get_class($parent));
50     $parent->shouldReceive('getCreatedAtColumn')->andReturn('created_at');
51     $parent->shouldReceive('getUpdatedAtColumn')->andReturn('updated_at');
52     $parent->shouldReceive('getForeignKey')->andReturn('taggable_id');
53     $parent->shouldReceive('getLocalKeyName')->andReturn('tag_id');
54     $builder = m::mock('IlluminateDatabase\Eloquent\Builder');
55     $builder->shouldReceive('getTable')->andReturn('tags');
56     $builder->shouldReceive('getModel')->andReturn($parent);
57     $builder->shouldReceive('getKeyName')->andReturn('tag_id');
58     $builder->shouldReceive('getOriginalClass')->andReturn(get_class($parent));
59     $builder->shouldReceive('join')->once()-with('taggables', 'taggable_id', 'tag_id', 'taggables_tag_id');
60     $builder->shouldReceive('where')->once()-with('taggables_taggable_id', 'tag_id', 'taggables_tag_id');
61 }
```

SOFTWARE

MICROCONTROLLER

- Microcontroller interfaces all the modules
 - Light, ultrasonic sensors
 - GSM module
 - Display



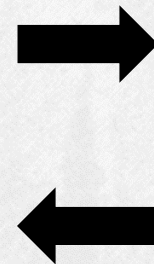
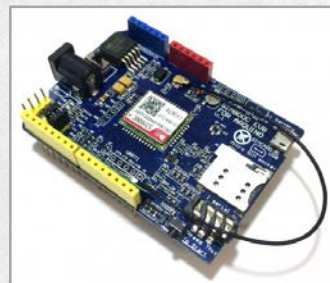
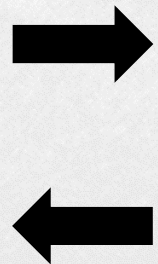
DISPLAY

- Interfaces with microcontroller through 3-pin SPI connection
- 2.5MHz SPI Clock
- Upload image data 250 bytes at a time



GSM MODULE- SIM800c

- AT commands are transmitted from microcontroller to GSM, they will:
 - Set up network connection
 - Connect to Solarity server
 - Request data from server
 - Read data from server
 - Transmit data to the microcontroller



**SOLARITY
SERVER**

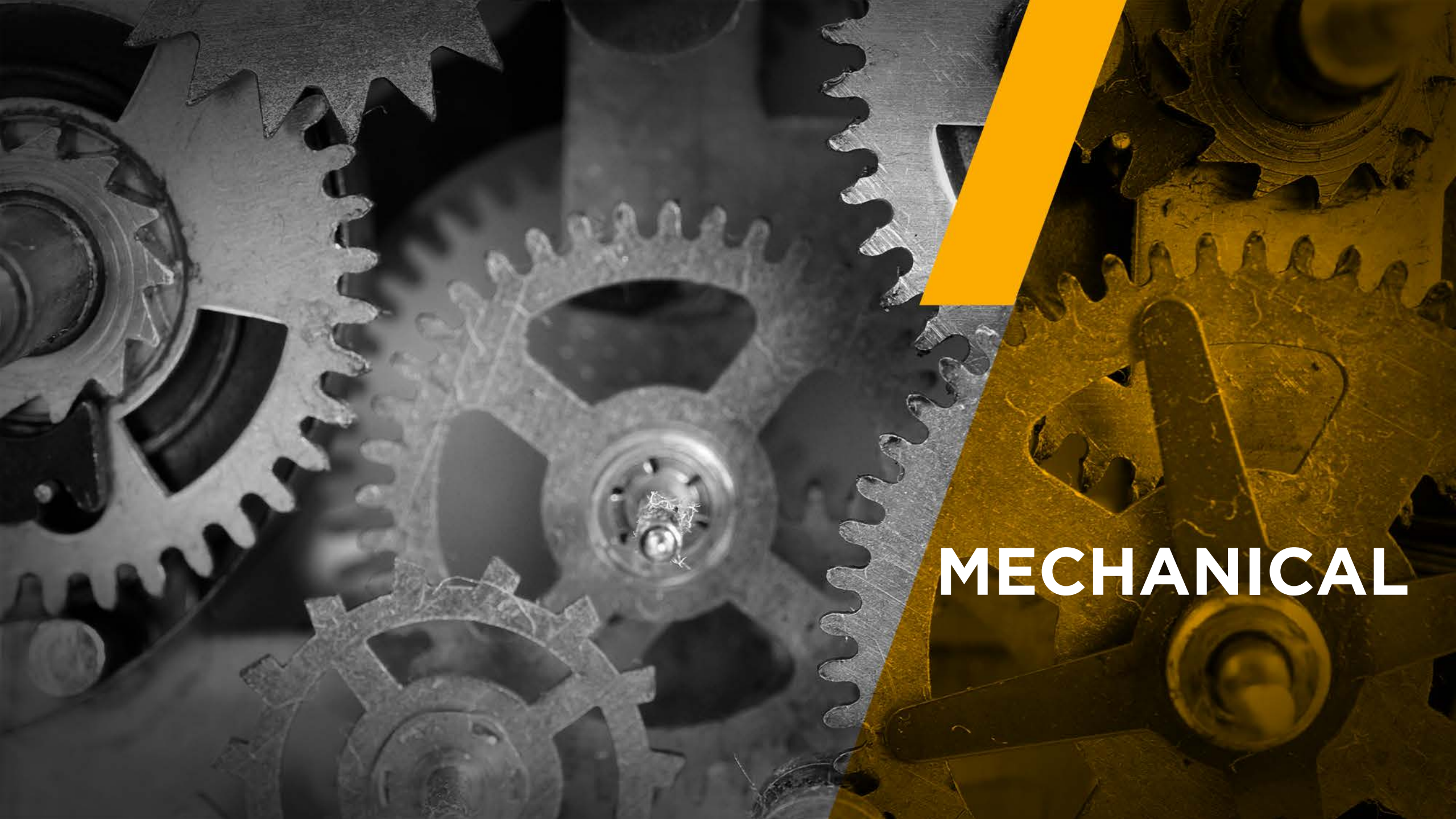
SERVER – MANAGER

Solarity Manager Configure and Deploy Solarity Devices

Device ID	Stop Number	Last Request	
mainDevice	60980	2015-11-15T01:42:05.464Z	<input type="button" value="Edit"/>
whoooo	60980	2015-12-05T03:01:50.195Z	<input type="button" value="Edit"/>
Edmonds	61977	2015-12-06T23:05:10.342Z	<input type="button" value="Edit"/>

Add a New Device

- Web-based configuration
- Device IDs are preassigned and unique to each Solarity device



MECHANICAL

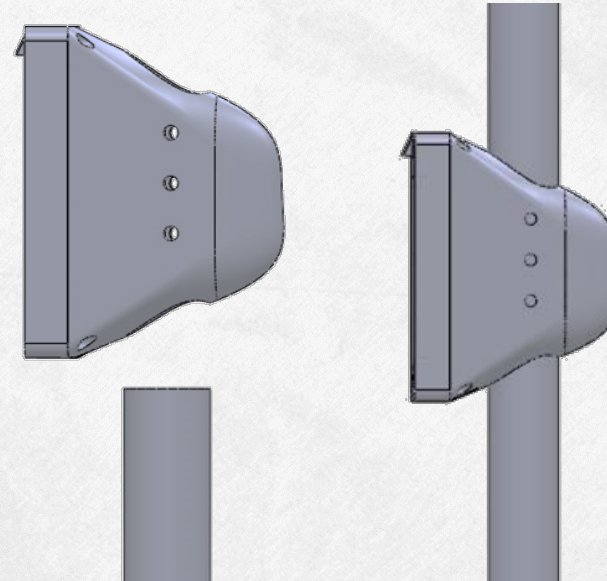
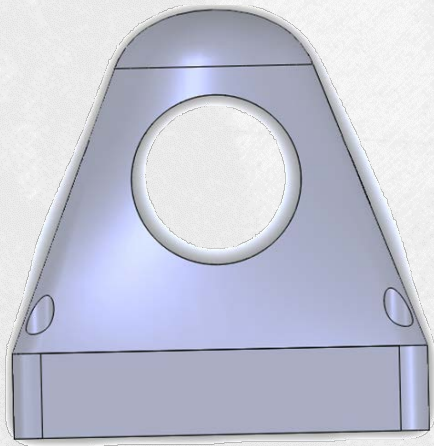
ENCLOSURE

- Three main risks
 - Theft
 - Vandalism
 - Weather



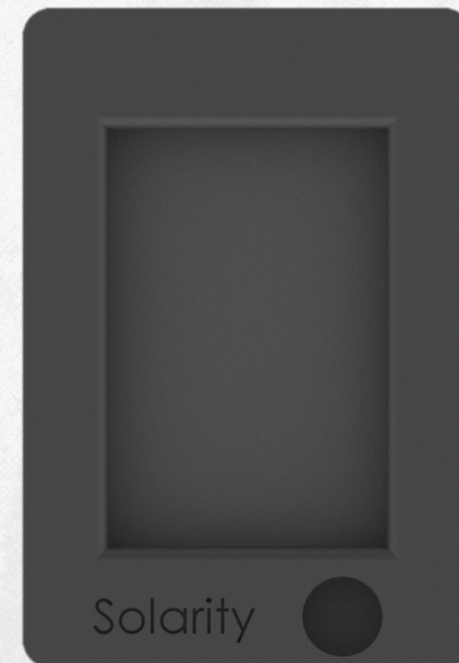
Theft Protection

- Only one way to remove device
- Secured with custom security screws
- Screw caps to hide screw head bit



Vandalism & Weather Protection

- Kydex® Thermoplastic Sheet
 - Excellent impact resistance
 - Low water absorption index
 - Outstanding formability
- Polycarbonate
 - Outstanding toughness
 - Good optical clarity
 - Strong and stiff
 - Easy to fabricate





BUSINESS ASPECTS

BUSINESS MODEL

- Solarity is intended to remove some of the stress involved in transit travel
- Simple as walking up to stop and receiving valuable travel information
- Our target market is not the end user, rather the transit provider
- Point of presence for transit provider

MARKET ANALYSIS

-SINCE WE LIVE IN BC, TRANSLINK IS OUR
PRIMARY TARGET

- Why would TransLink want Solarity?
 - Improve user satisfaction
 - Increase ridership [3] [4] [5]
 - Advertising

MARKET ANALYSIS

-COMPETITION

Some Popular Mobile Applications:



The Transit App

iOS 4.5/5.0

Android 4/5



**Radar for Metro
Vancouver Buses**

iOS
5/5



BusLink

Android
4.5/5



Live Transit

Android
4/5

MARKET ANALYSIS

-WHY SOLARITY

- Wider customer base – tourists, elderly
- No personal info or location required (Privacy)
 - One less outlet to share personal data
- Ability to display any information
- Users associate device as part of TransLink unlike third-party apps
- Ads can be “annoying” when on seen on cellphones

BUDGET & FINANCING

Components	Estimation Price	Actual Price
Microcontroller	\$20	\$17.73
GSM Module	\$75	\$80.44
Display	\$175	\$166.66
Solar Panel	\$175	\$0 (Had access to one)
Battery and charging circuit	\$50	\$50.40
Cable and Miscellaneous Electronics	\$50	\$182.97
Housing	\$75	\$120.00
Contingency (25%)	\$155	\$43.84
Total	\$775	\$662.04

PROJECT TIMELINE





**TIME TO
REFLECT**

LESSONS **LEARNED**

- Integration takes a long time
- Debugging software requires lots of time
- Parts sometimes break or don't work

FUTURE IMPROVEMENTS

- Bigger screen during production
- Advertising (increase revenue)
- Additional optimization for better efficiency

ACKNOWLEDGEMENTS

- Dr. Andrew Rawicz
- Steve Whitmore
- the TA's
- Rob Church & Jeff Vogstad (from TransLink)
- Fred Heep
- Gary Shum
- Ken Kaarvik

CONCLUSION

- Sunlink's Solarity provides an energy and cost effective solution for the betterment of transit
- Aim to draw more people away from driving to take public transit by enhancing the experience
- Our schedule and budget were followed closely, and the prototype meets most of our project functional requirements.



QUESTIONS



DEMO



Thank you!
Have a great day

REFERENCES

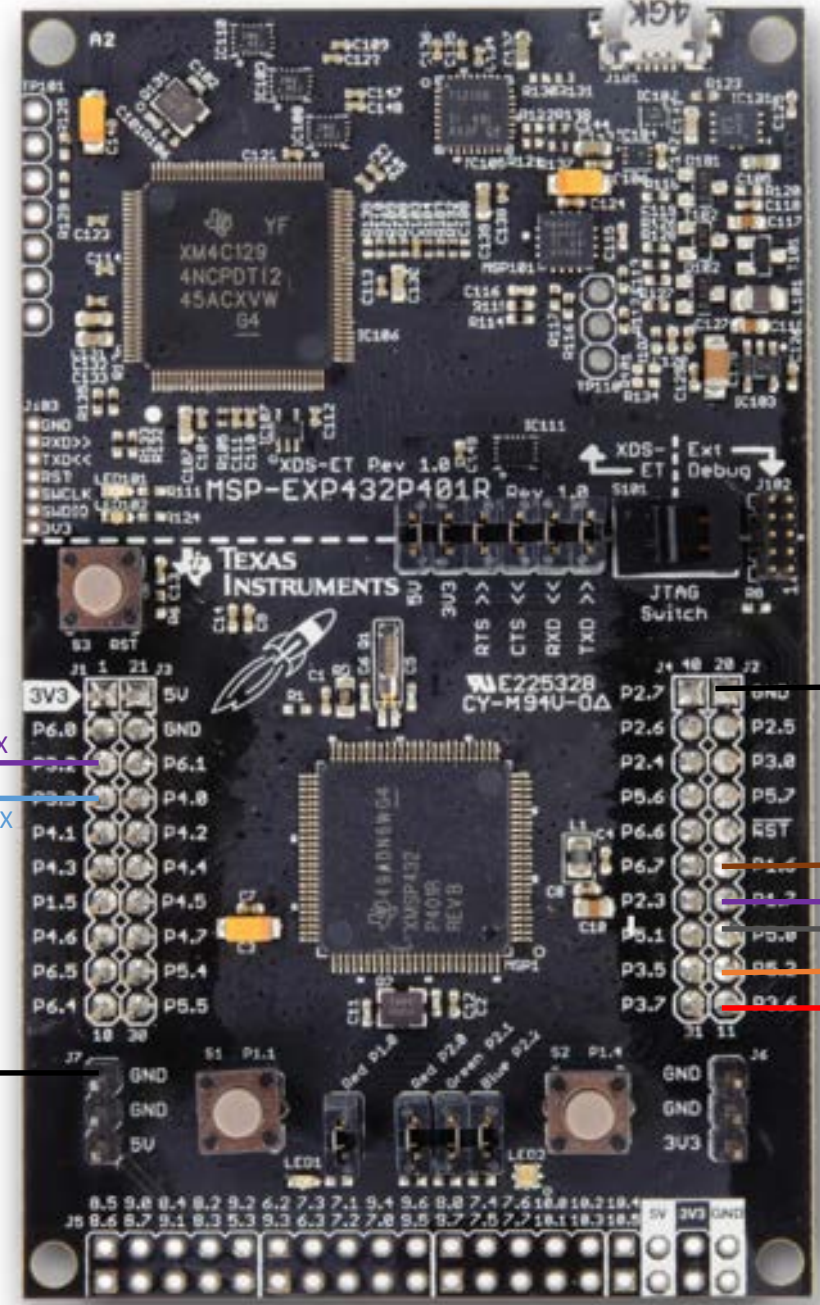
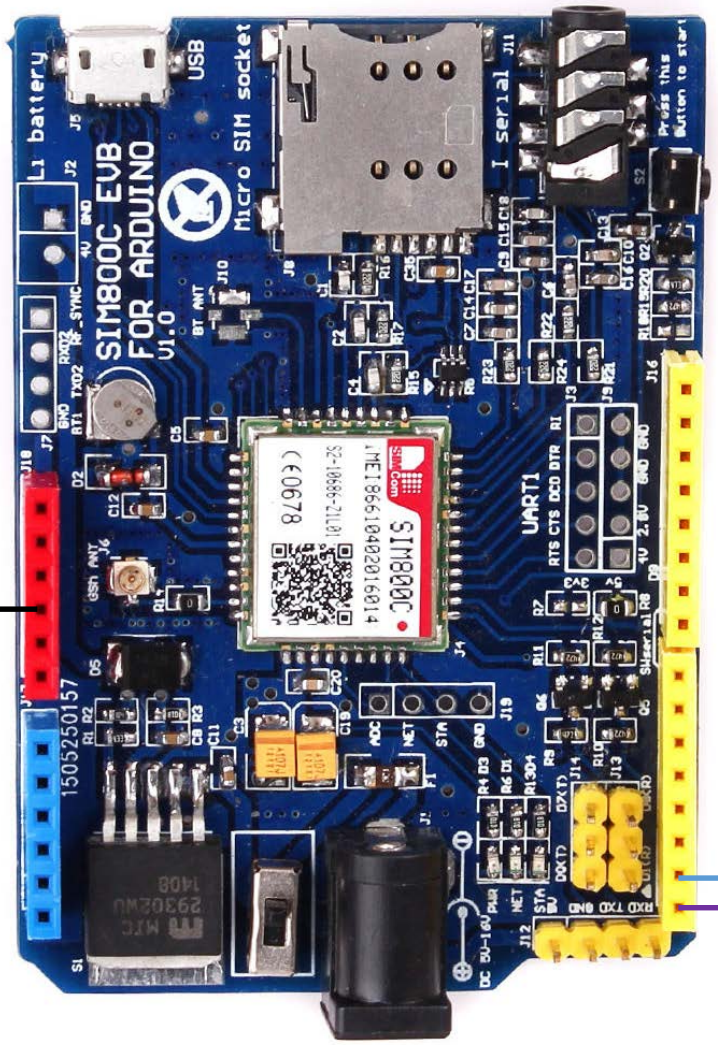
- [1] ti.com, 'MSP-EXP432P401R', 2015. [Online]. Available: <http://www.ti.com/ww/en/launchpad/launchpads-msp430-msp-exp432p401r.html>. [Accessed: 01-Dec-2015].
- [2] inaexpress.com, 'SIM800c Shield Development Board For Arduino', 2015. [Online]. Available: <http://inaexpress.com/products/sim800c-shield-development-board-for-arduino-instead-of-sim900-module-gprs-gsm-4-frequency-available/>. [Accessed: 01-Dec-2015].
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- [4] Brakewood, C., Macfarlane, G. S., & Watkins, K. (2015). The impact of real-time information on bus ridership in New York City. *Transportation Research Part C: Emerging Technologies*, 53, 59-75.
- [5] Metro Focus (2012). Comparing Urban Bus Tracking Systems and Ridership <http://www.thirteen.org/metrofocus/2012/03/does-knowing-count-comparing-urban-bus-tracking-systems-and-ridership/>

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https://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?&num=057140&lat=49.28&submit=Submit&hgt=100&veg=17&sitelev=&email=skip@larc.nasa.gov&p=grid_id&p=swvdowncook&p=clrskyday&p=swv_dwn&p=daylight&p=mnavail1&step=2&lon=-123.12

TI MSP432P401R Microcontroller

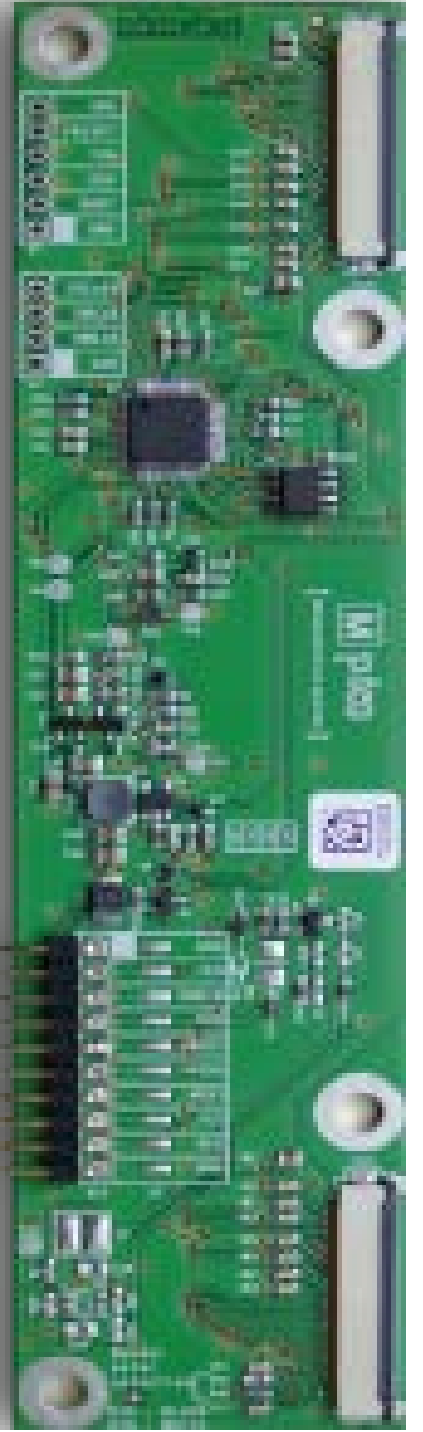
GSM Shield Sim 800c



- GND
- EN
- MOSI
- MOSO
- CS
- EN
- BUSY

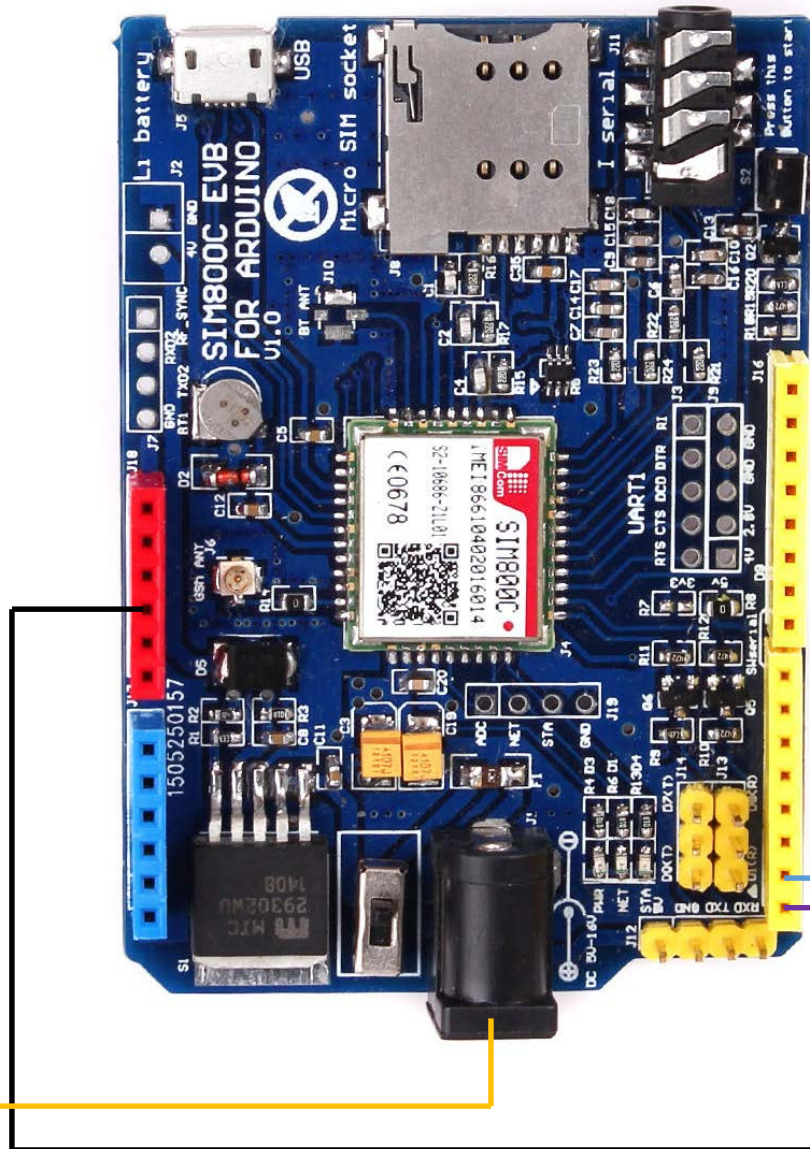
- GND
- VDDIN
- VIN
- BUSY
- MISO
- MOSI
- CS
- SCK
- GND

MPico Pervasive Display



TI MSP MSP432P401R Microcontroller

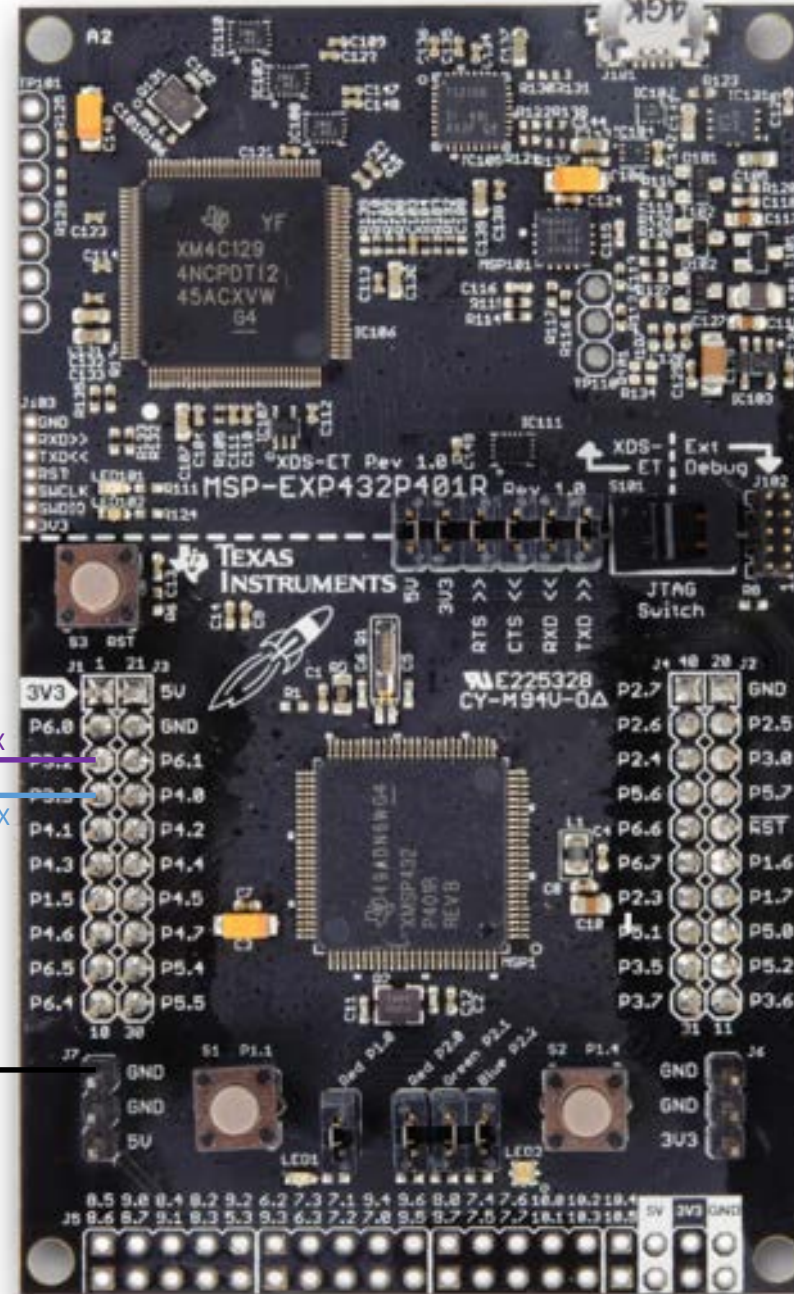
GSM Shield Sim 800c



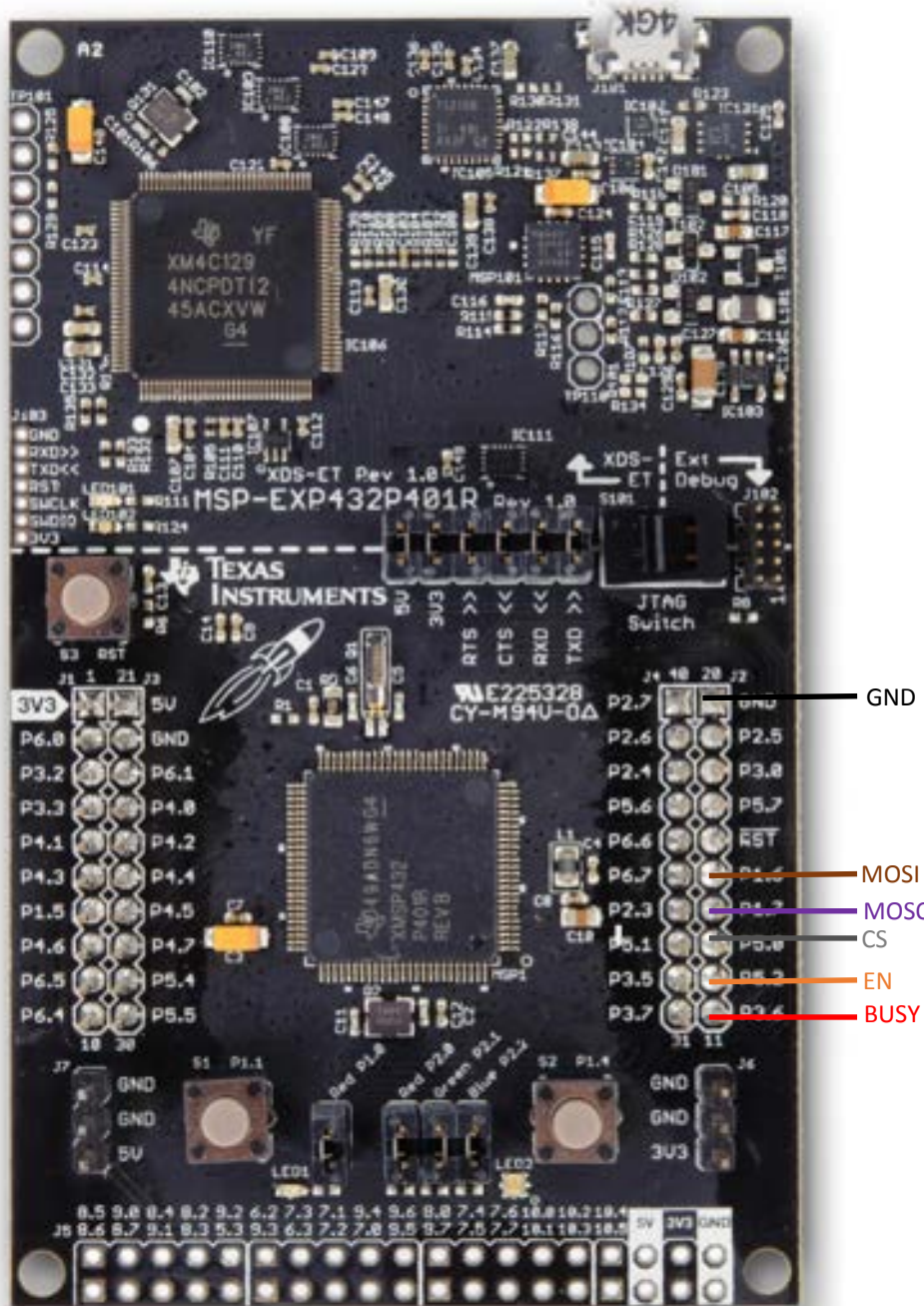
Battery

RX

TX



TI MSP MSP432P401R Microcontroller



MPico Pervasive Display

GND

MOSI

MOSO

CS

EN

BUSY

GND

EN

VDDIN

VIN

BUSY

MISO

MOSI

CS

SCK

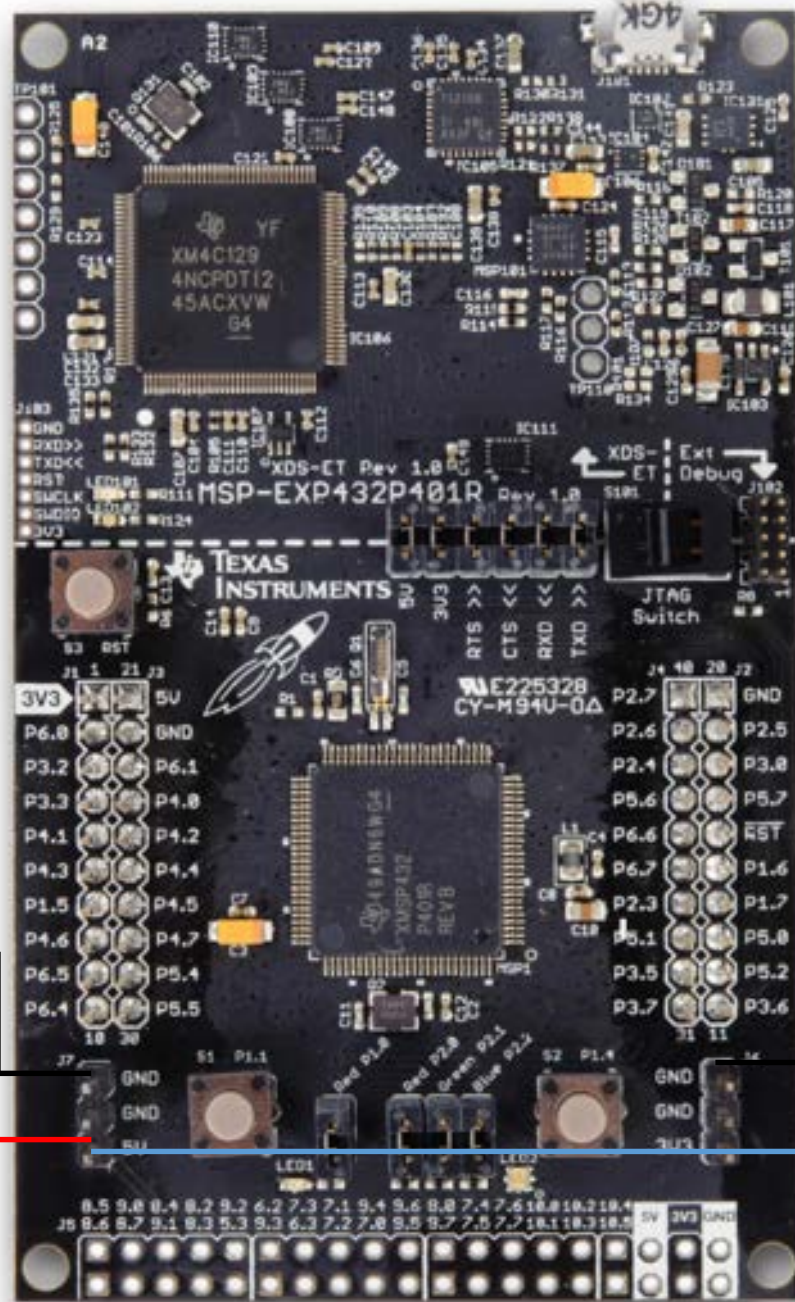
GND

TI MSP MSP432P401R Microcontroller

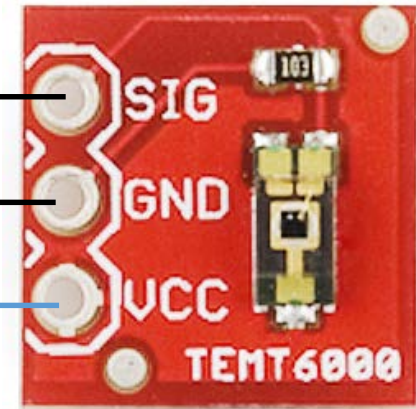
SparkFun Ambient Light Sensor



To Analog pin

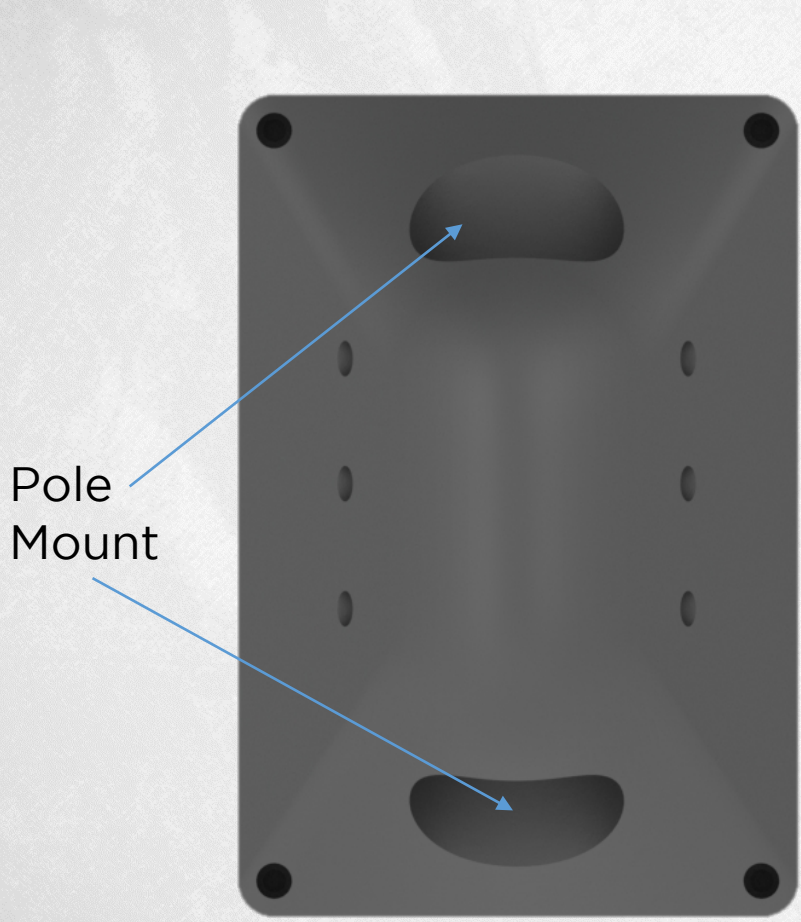


LV-MaxSonar-EZ0 Proximity Sensor



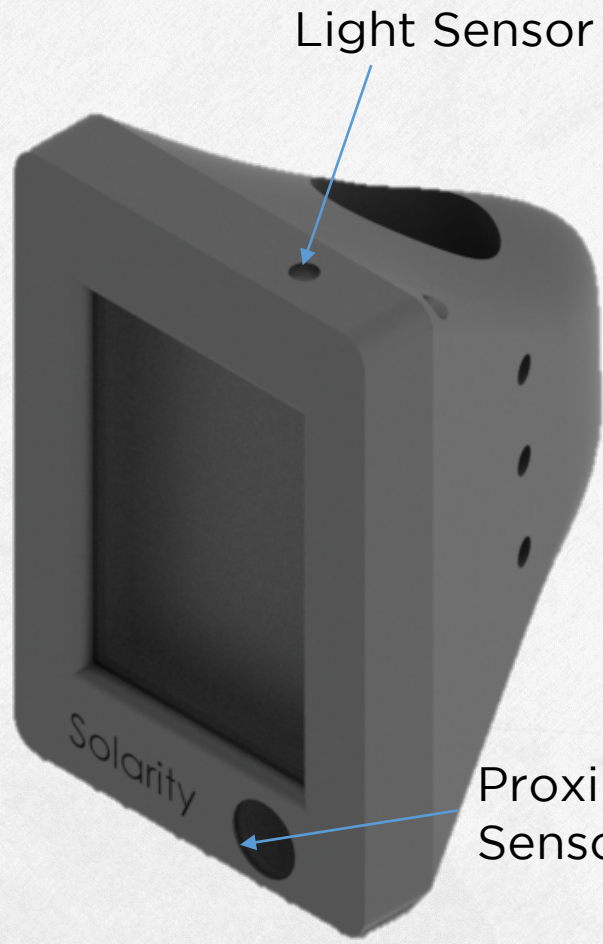
To Analog pin





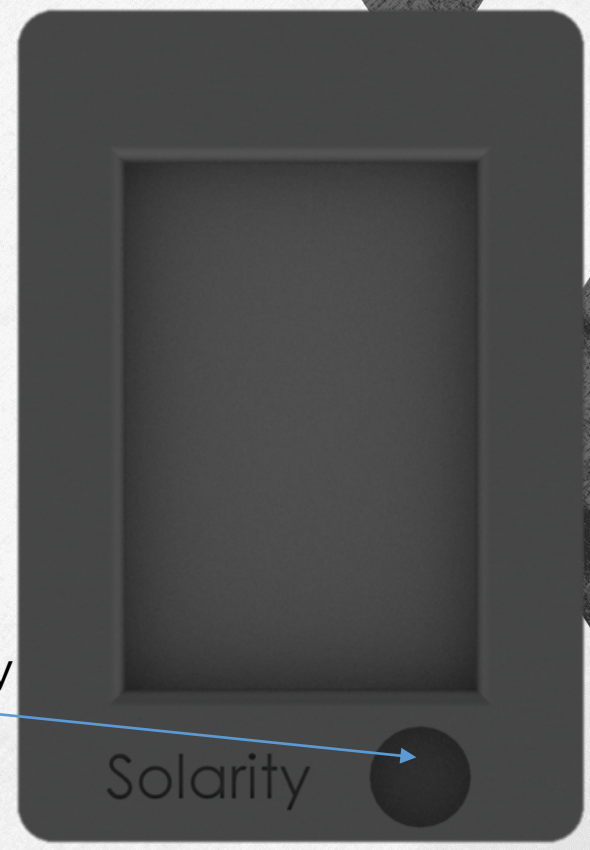
Pole Mount

Back View



Light Sensor

Perspective View



Proximity Sensor

Front View