
Current Time
RAMON QUINONES
0 4 12
Current Score
PITTSBURG ST U 2
07 : 57
4 Penalty
U OF CNTRL MO 1
0 : 0 : 0
98

AIAA Telemetry/Electronics Award Team

Pittsburg State University 2016-2017

ROVER VIEW

NASA Human Exploration ROVER CHALLENGE

AIAA

The World's Forum for Aerospace Leadership

INTRODUCTION

Daniel Meyer
Carthage, MO
Mechanical: Electromechanical

Keanan Smith
Edna, KS
Mechanical: Electromechanical

Tim Morrison
Hot Springs, AR
Mechanical: Manufacturing

Abdulaziz Alshehri
Saudi Arabia
Mechanical: Design

Abdullah Alfehan
Saudi Arabia
Mechanical: Design

AIAA TELEMETRY / ELECTRONICS AWARD

"[The award] recognizes the development and operation of the most innovative and useful real-time telemetry system at the Rover Challenge."

AIAA

The World's Forum for Aerospace Leadership

AIAA TELEMETRY / ELECTRONICS AWARD

The telemetry system must do one of the following tasks:

Transmit real-time video
Transmit real-time sensor data

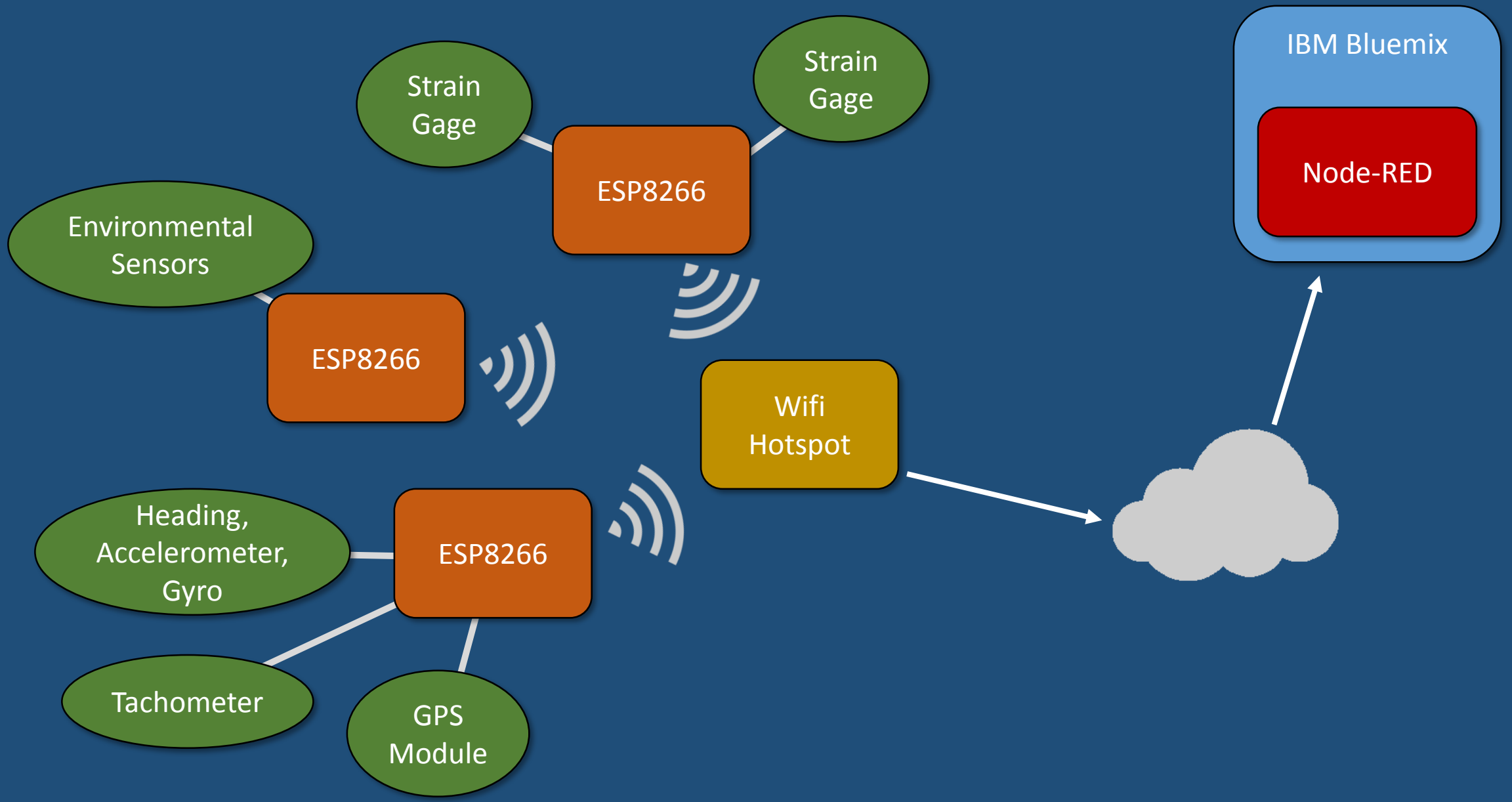
We accomplished both tasks.

SYSTEM OVERVIEW

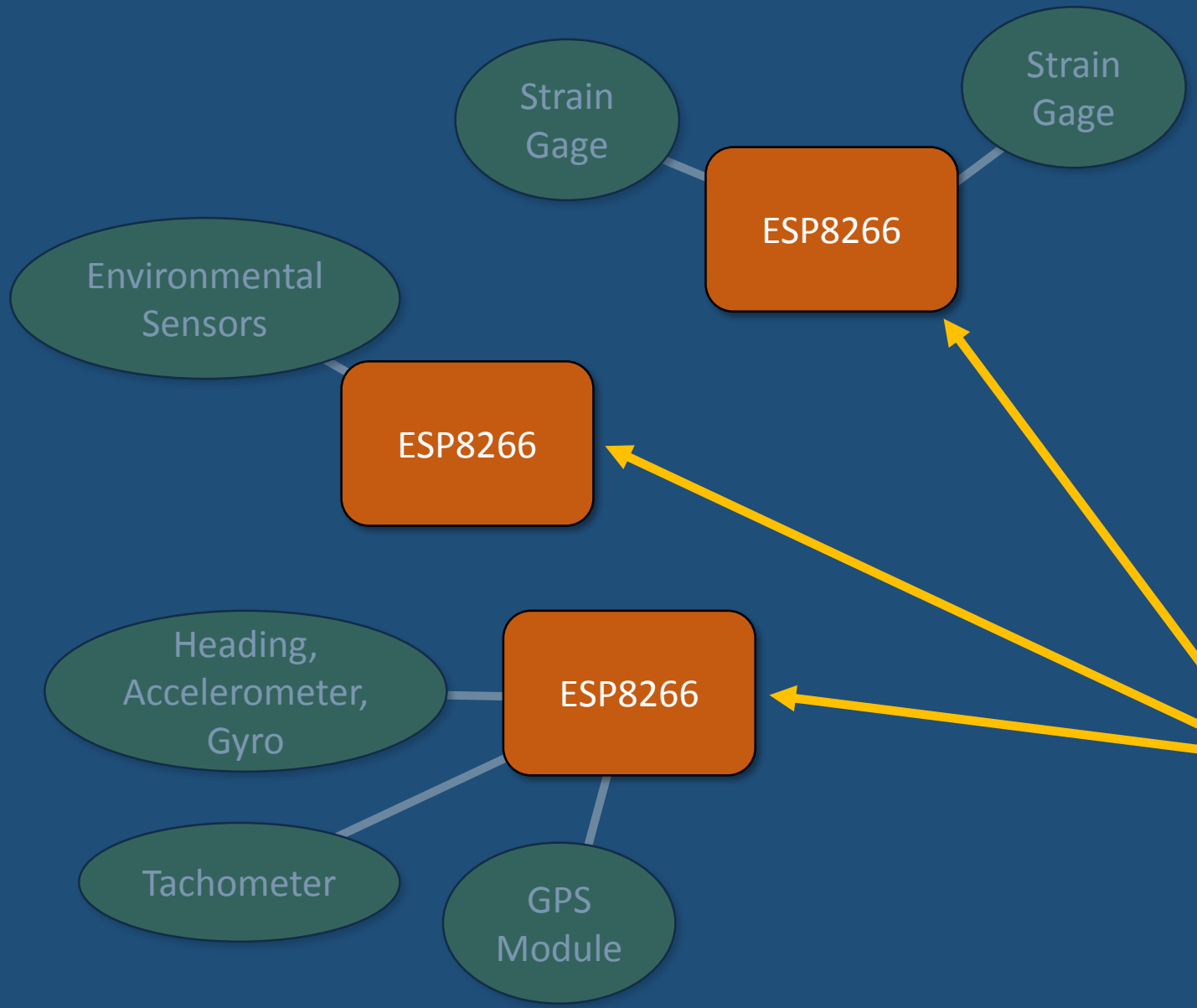
Four Categories of Data Collection:

- Vehicle Performance
- Geolocation
- Environmental
- Video

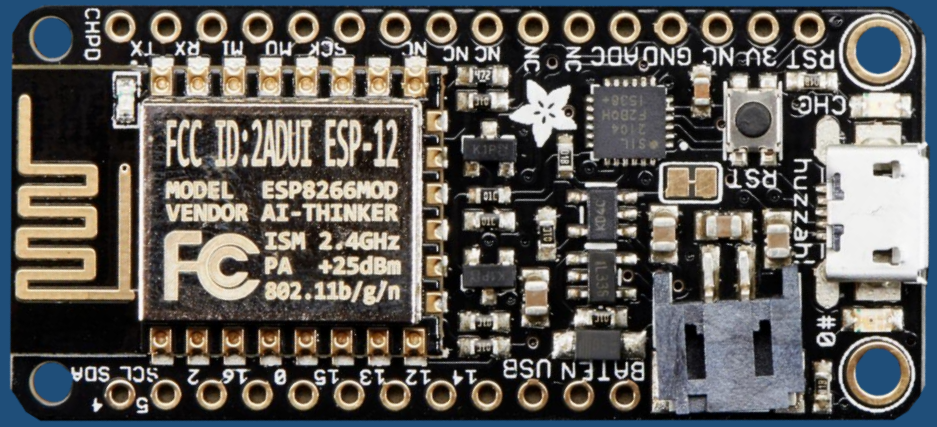
ROVER VIEW OVERVIEW



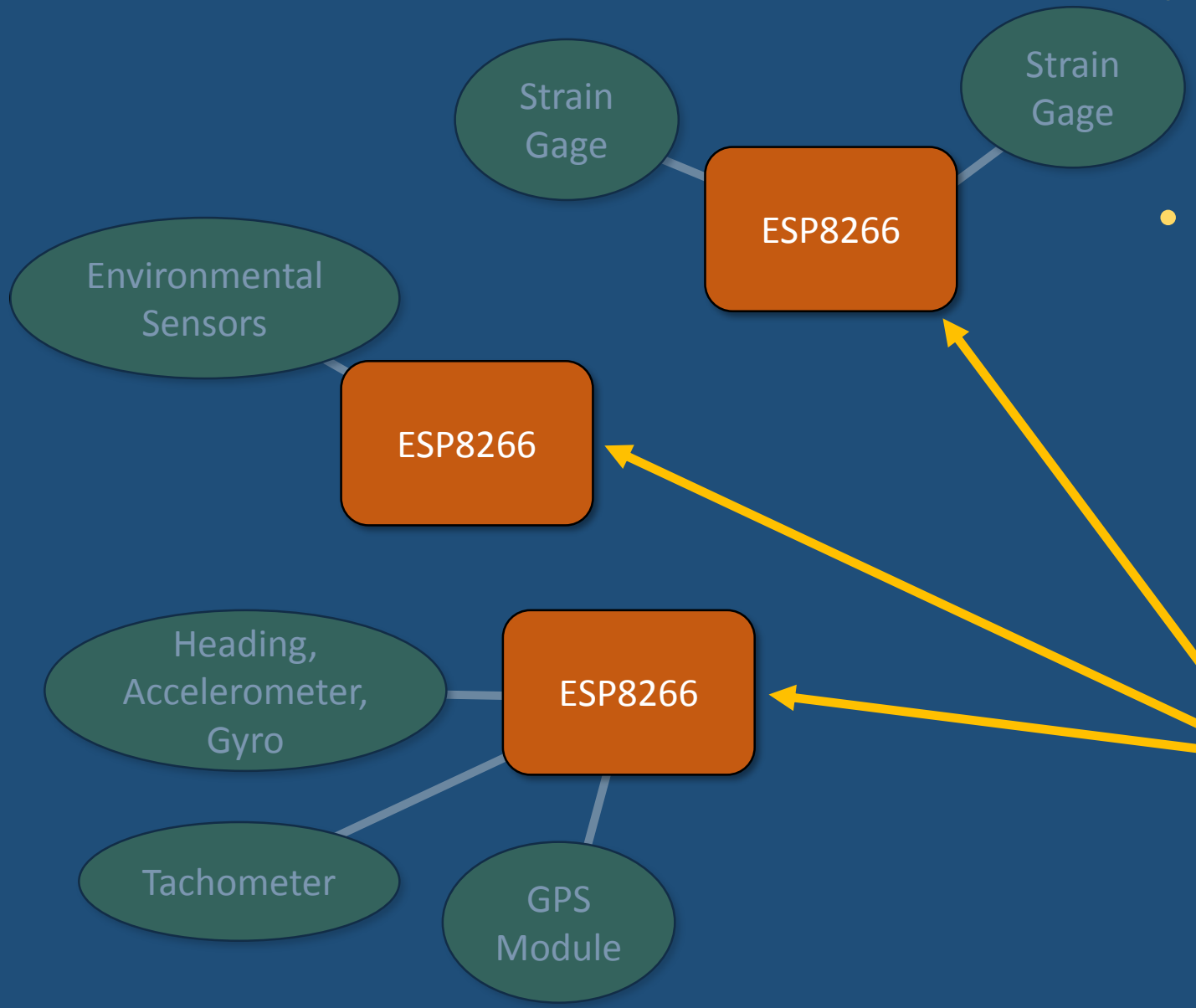
ON-ROVER MODULES



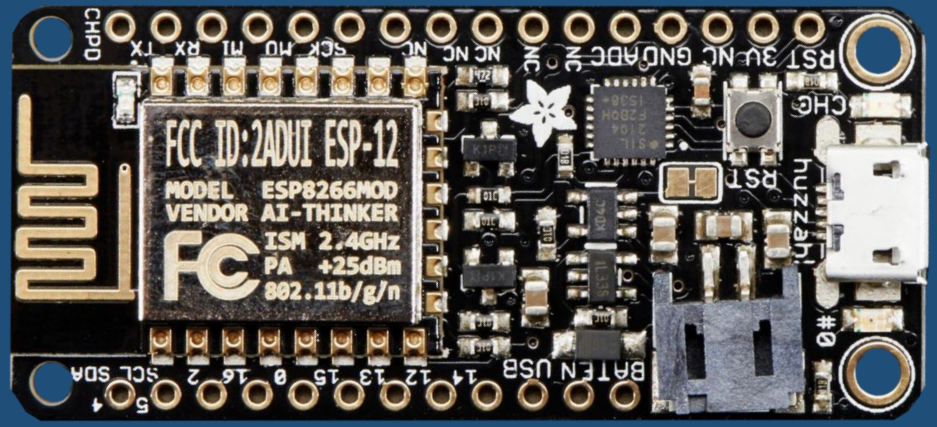
- ESP8266 SOC modules form the backbone of our sensor collection network
- Each ESP8266 connects directly to the base station with its own built-in Wifi networking



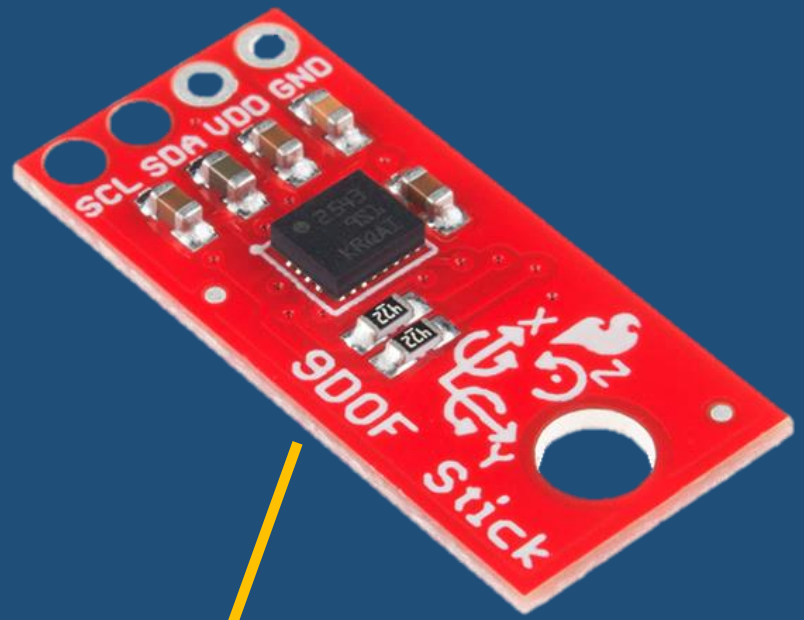
ON-ROVER MODULES



- ESP8266 modules can be added modularly as the situation requires.
- No need to build extensive wiring harnesses as an ESP can be placed physically near sensors.



ON-ROVER MODULES



LSM9DS1 board collects:

- 3-axis accelerometer
- 3-axis gyroscope
- 3-axis magnetometer

"9 Degrees of Freedom"

Heading, Accelerometer, Gyro

ESP8266

GPS Module

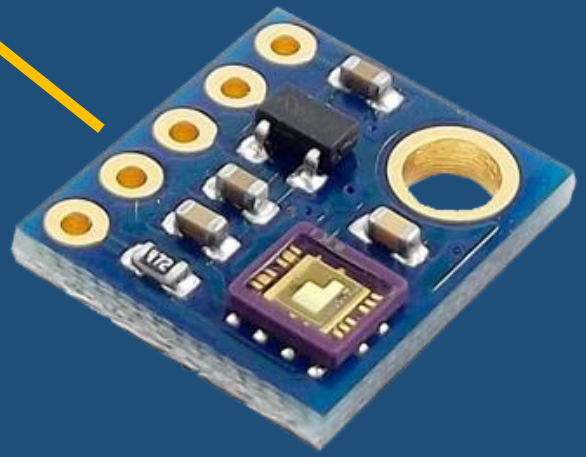
Crius NEO-6 provides GPS coordinates and altitude plus accurate timing

ON-ROVER MODULES

Environmental Sensors

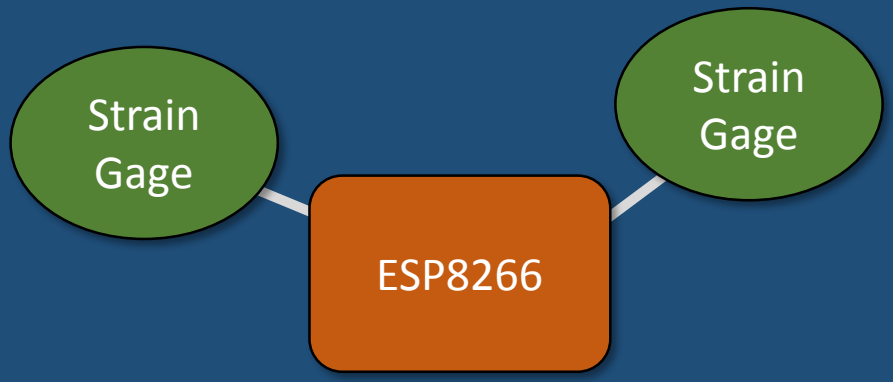
ESP8266

BME280 measures pressure, temperature, and humidity



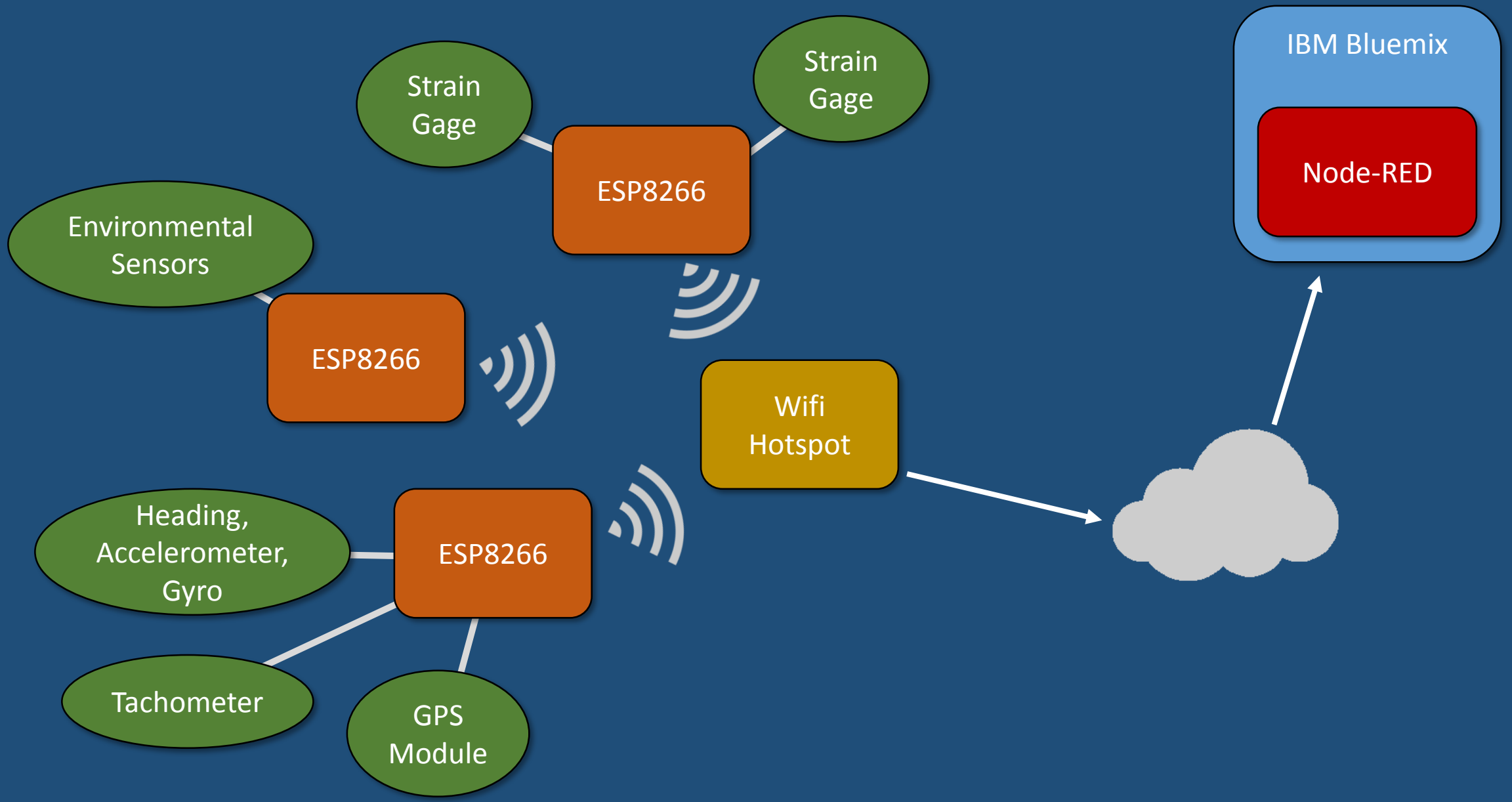
ML8511 returns UV Intensity (mW/cm^2)

ON-ROVER MODULES

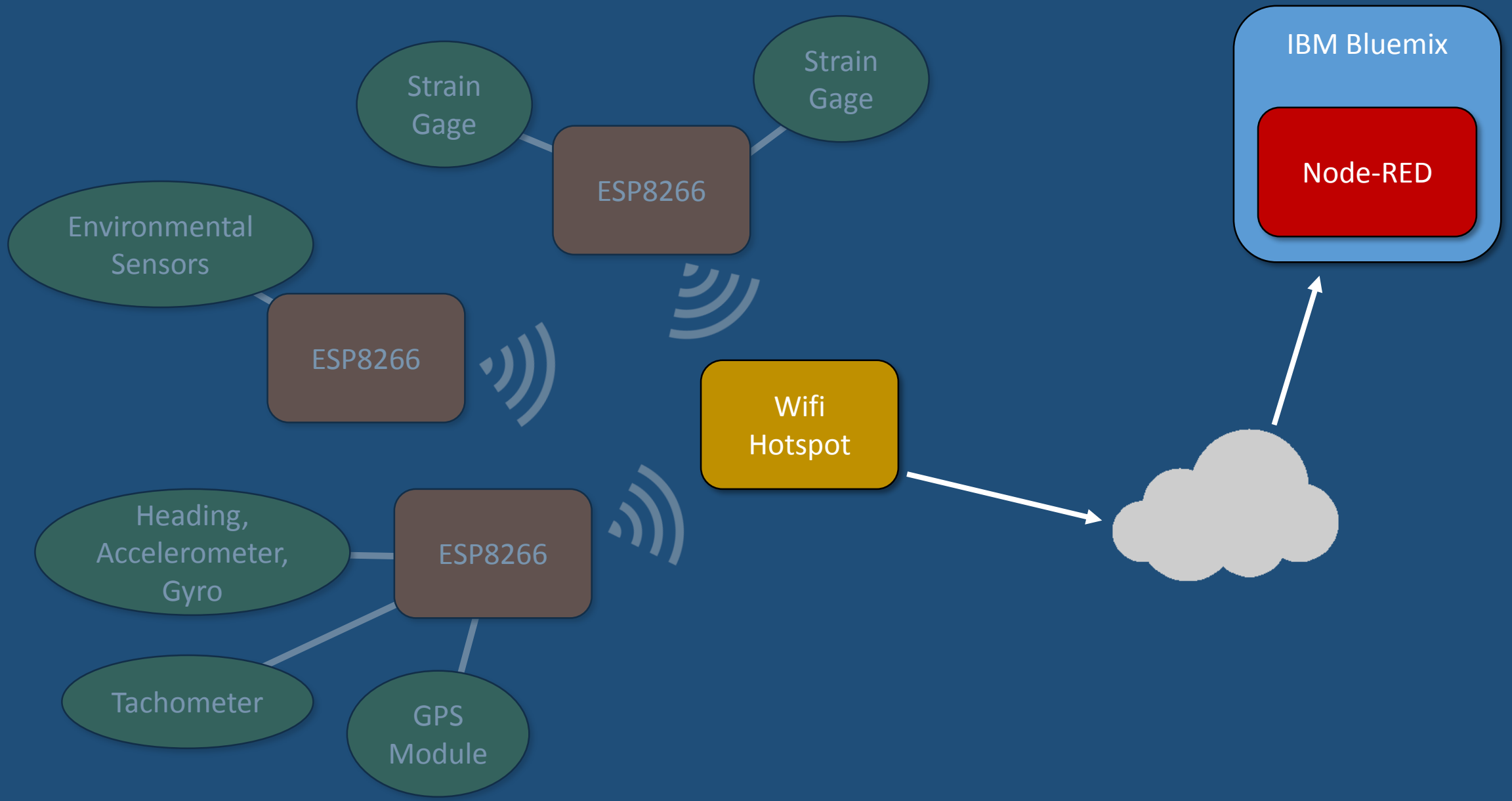


- Additional ESP8266 modules collect strain readings from rover frame
- A variety of strain gage models are used depending on configuration

ROVER VIEW OVERVIEW



ROVER VIEW OVERVIEW



CLOUD SERVICES

IBM Bluemix

Node-RED

IBM Cloudant®

CLOUD SERVICES

- IBM Bluemix: Enterprise cloud computing platform
- “Platform As A Service”: servers for rent to run computer applications

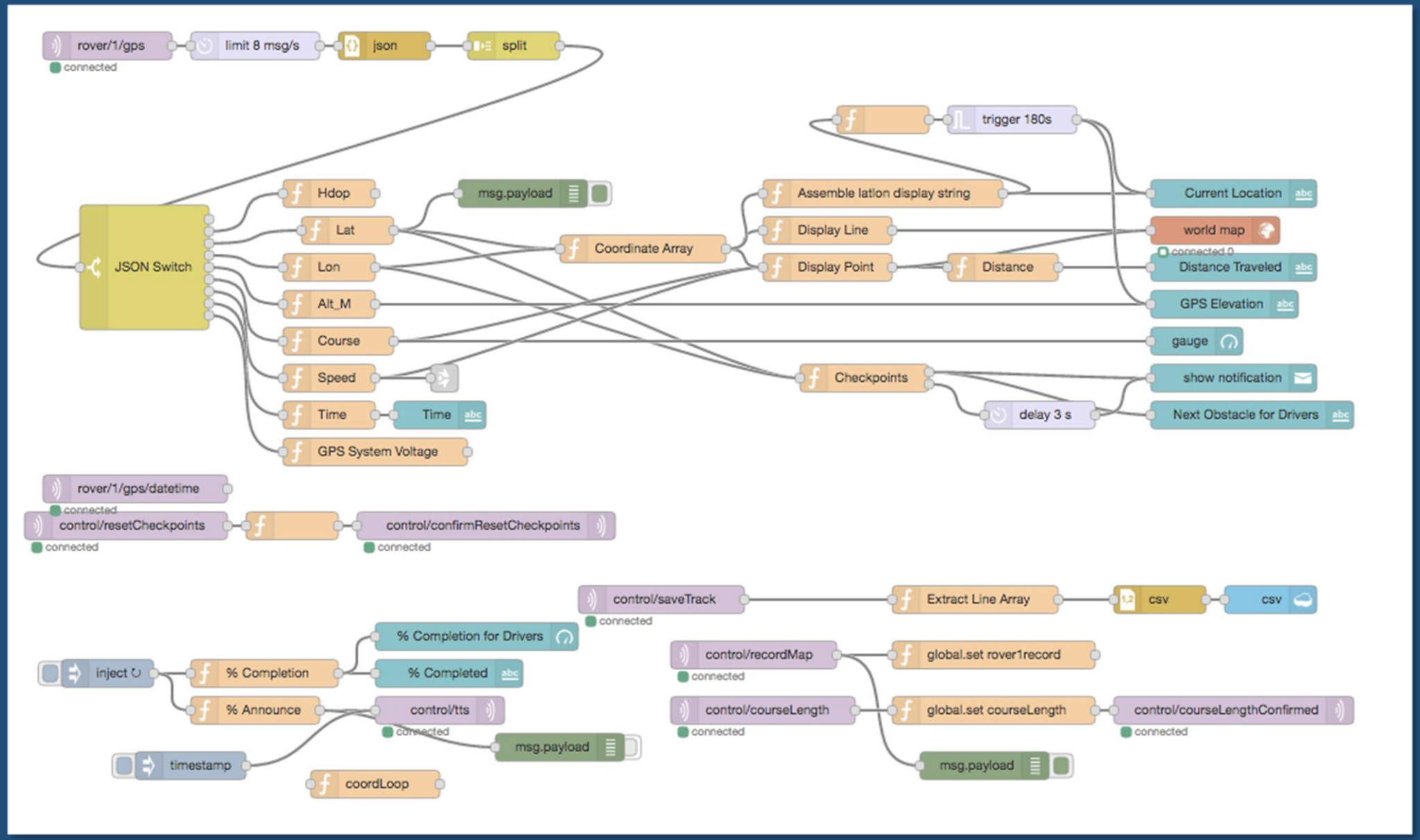
CLOUD SERVICES

IBM Bluemix

Node-RED

- Node-RED: application running on Bluemix servers
- Creates web-hosted dashboard

CLOUD SERVICES



CLOUD SERVICES

- Cloudant NoSQL database: hosted on Bluemix servers
- Stores data recorded in races

CLOUD SERVICES

IBM Bluemix

Node-RED

IBM Cloudant®

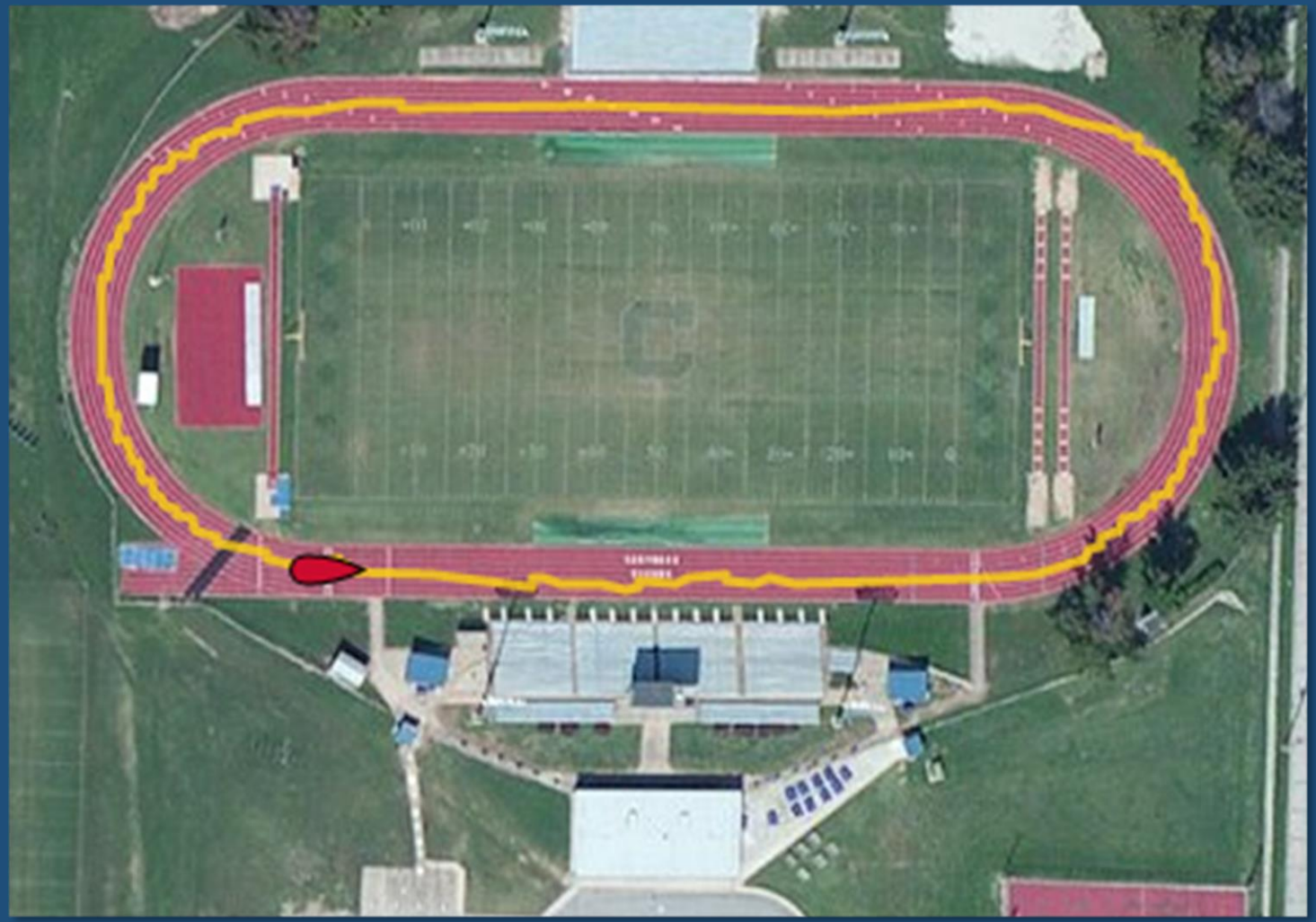
VIDEO STREAMING

- Smartphone app streams directly to YouTube
- Quick and simple to start recording
- Can be viewed directly on dashboard

MODULE ENCLOSURES

- 3D printed from durable ABS plastic
- House and protect delicate electronics
- Clips facilitate quick swapping between rovers
- Tested tough through sand and rocks

TESTING



TESTING

REVISIONS

Original Idea	Revision	Advantage
High-Gain Wifi Antenna	Cellular Transmission	Eliminates Range and Terrain Restrictions
Local Application Hosting	Bluemix Cloud Services	Allows many simultaneous users and offloads uptime responsibilities from us
RF Video Antenna	Direct to YouTube Streaming	Many simultaneous users, Ease of distribution and recording

Bill of Materials

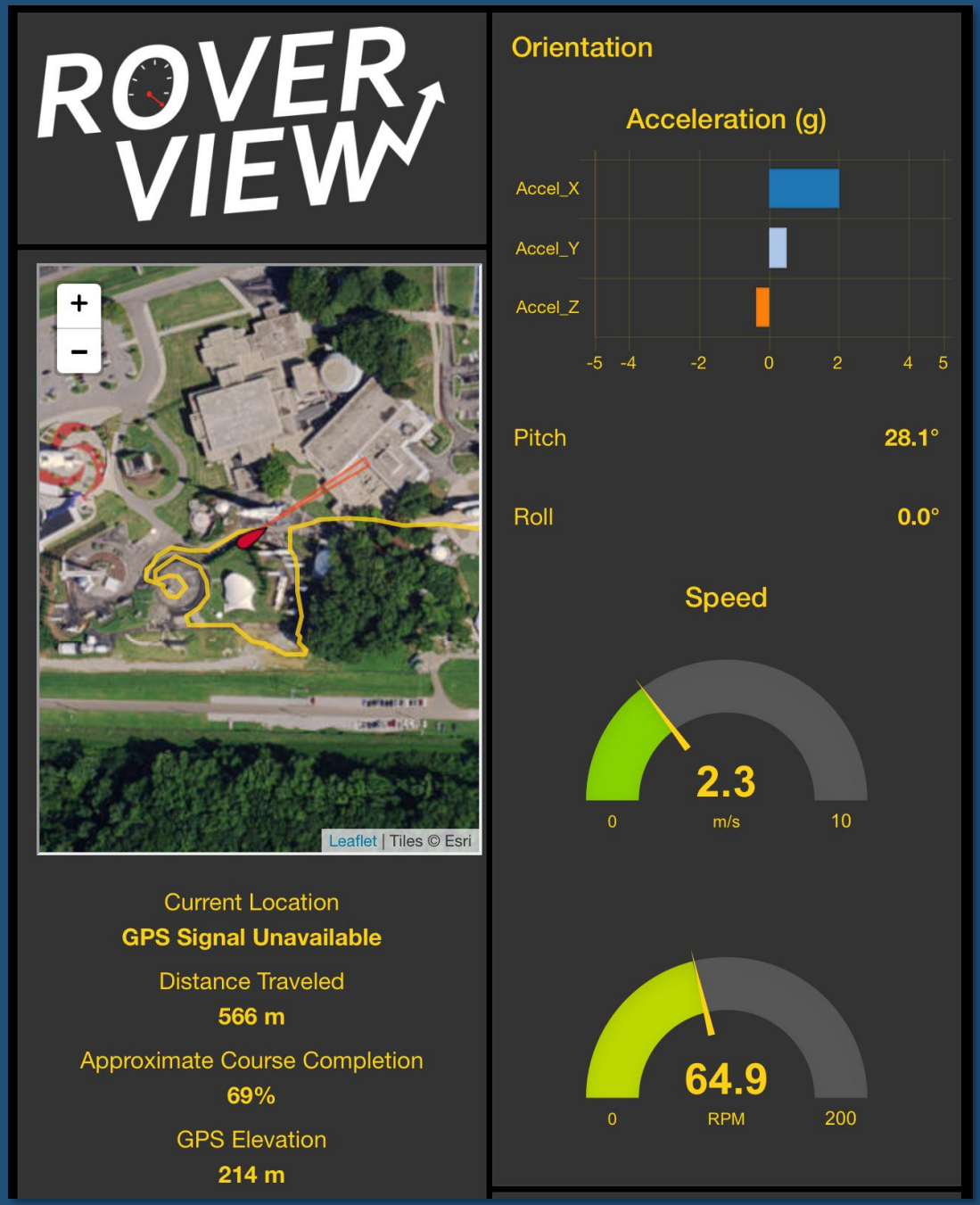
Module	Function	Qty	Unit Price	Total
ESP8266	Microcontroller	6	$9.00	$54.00
Crius GPS	GPS Positioning	1	$20.00	$20.00
9Dof Stick	9 Degrees of Freedom	1	$15.00	$15.00
INA125	Instrument Amplifier	3	$7.00	$21.00
ADS 1115	Analog-Digital Converter	4	$3.00	$12.00
S7V8F3	3.3V Buck-Boost Converter	6	$6.00	$36.00
ML8511	UV Sensor	1	$4.00	$4.00
BME280	Temp/Pressure/Humidity	1	$5.00	$5.00
3.7V Lipo	720mAh Battery	6	$3.17	$19.00
				$186.00

COMPETITION DAY

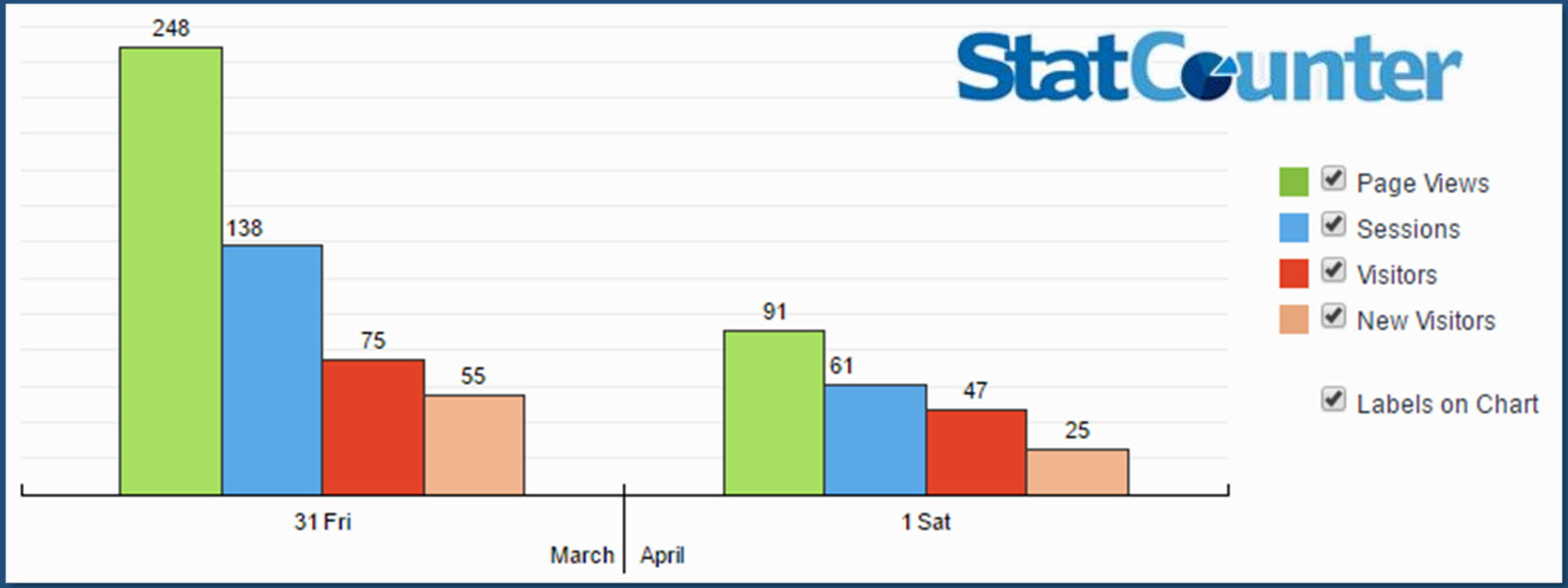
Banners advertised availability of a public dashboard to view live sensor data and video

COMPETITION DAY

- Live GPS point and history track
- Motion data
- Speed, Drivetrain RPM
- Strain Data
- Environmental

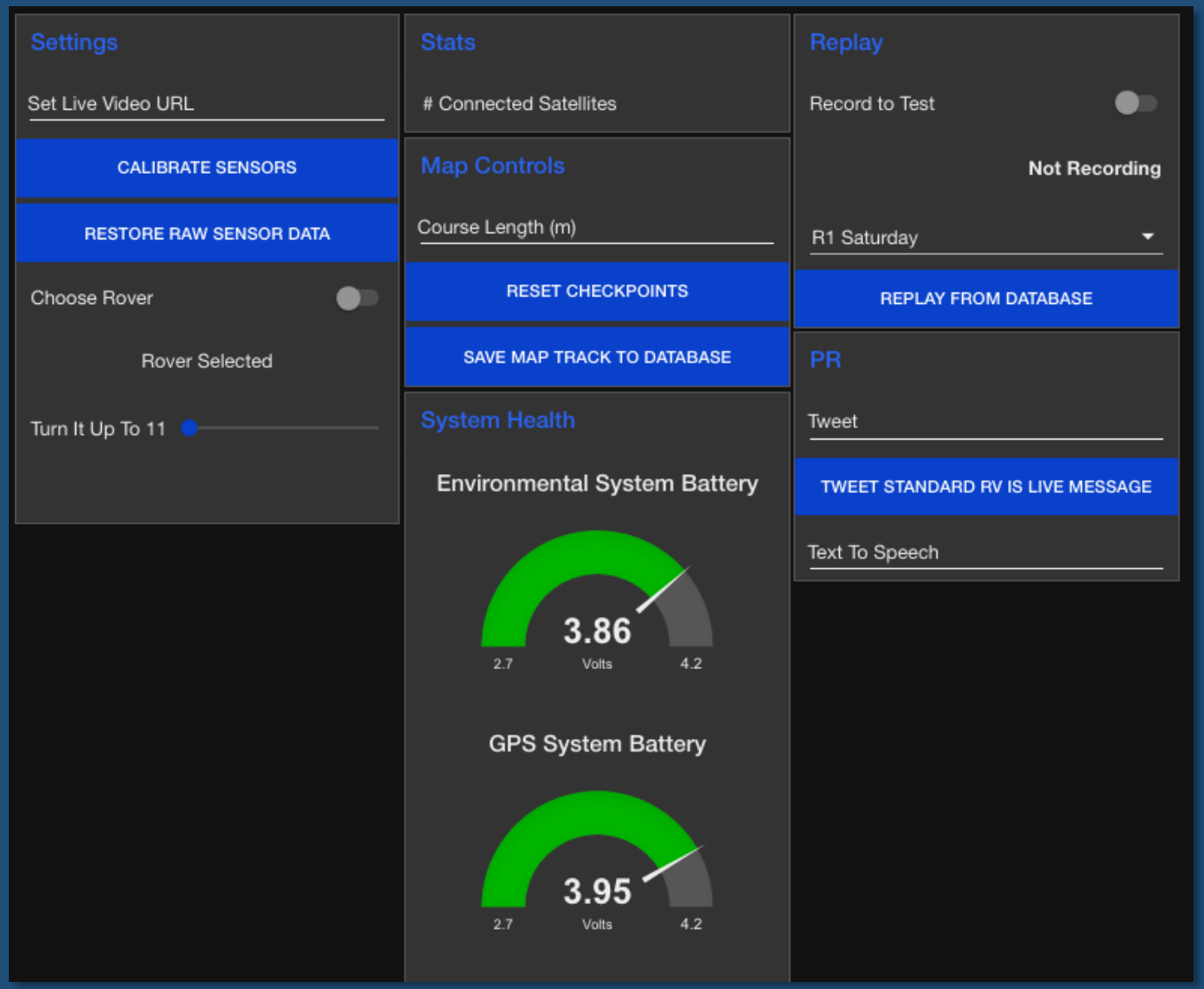


COMPETITION DAY



- 339 Weekend Page Views
- 122 Unique Users

COMPETITION DAY

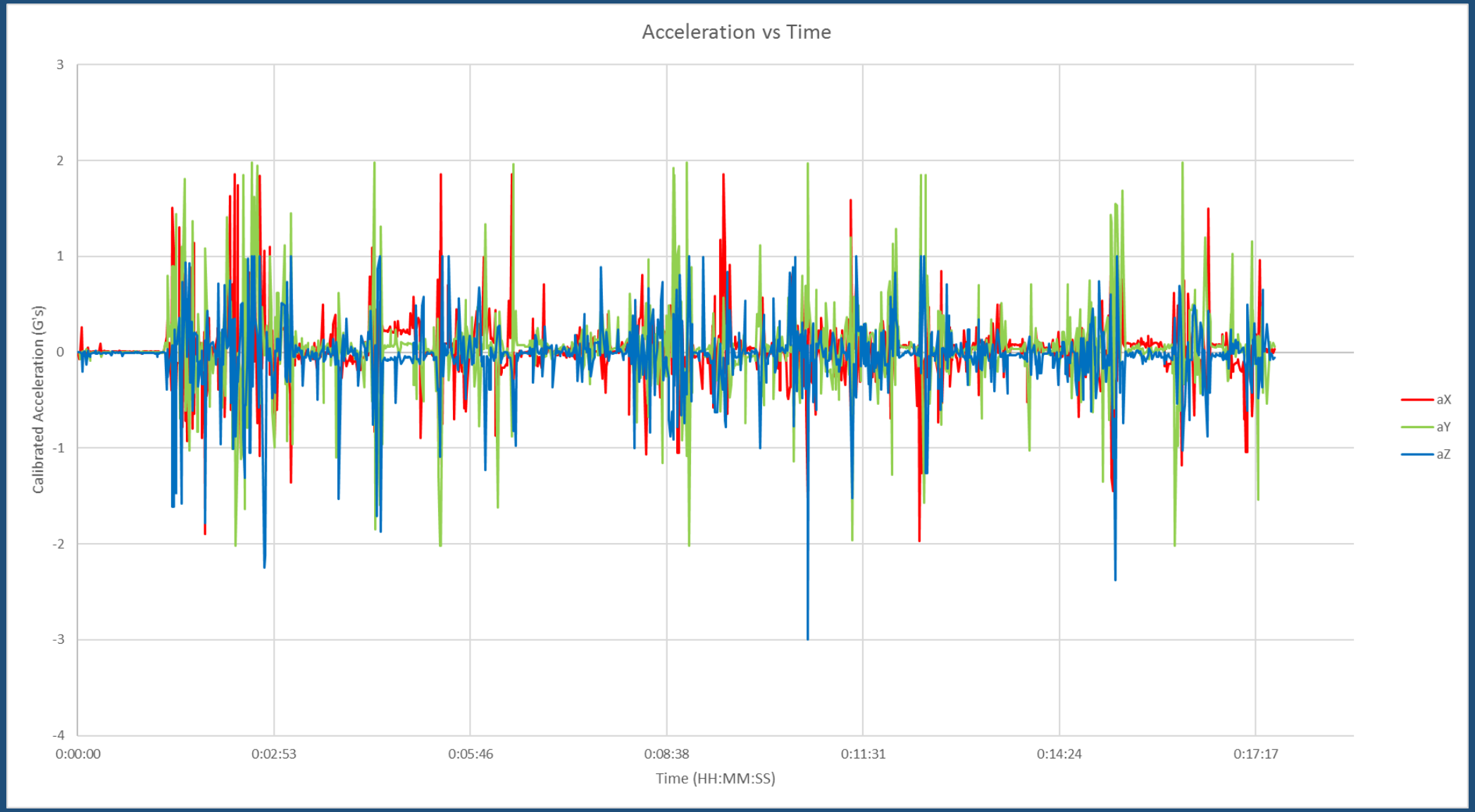


Private Control Dashboard

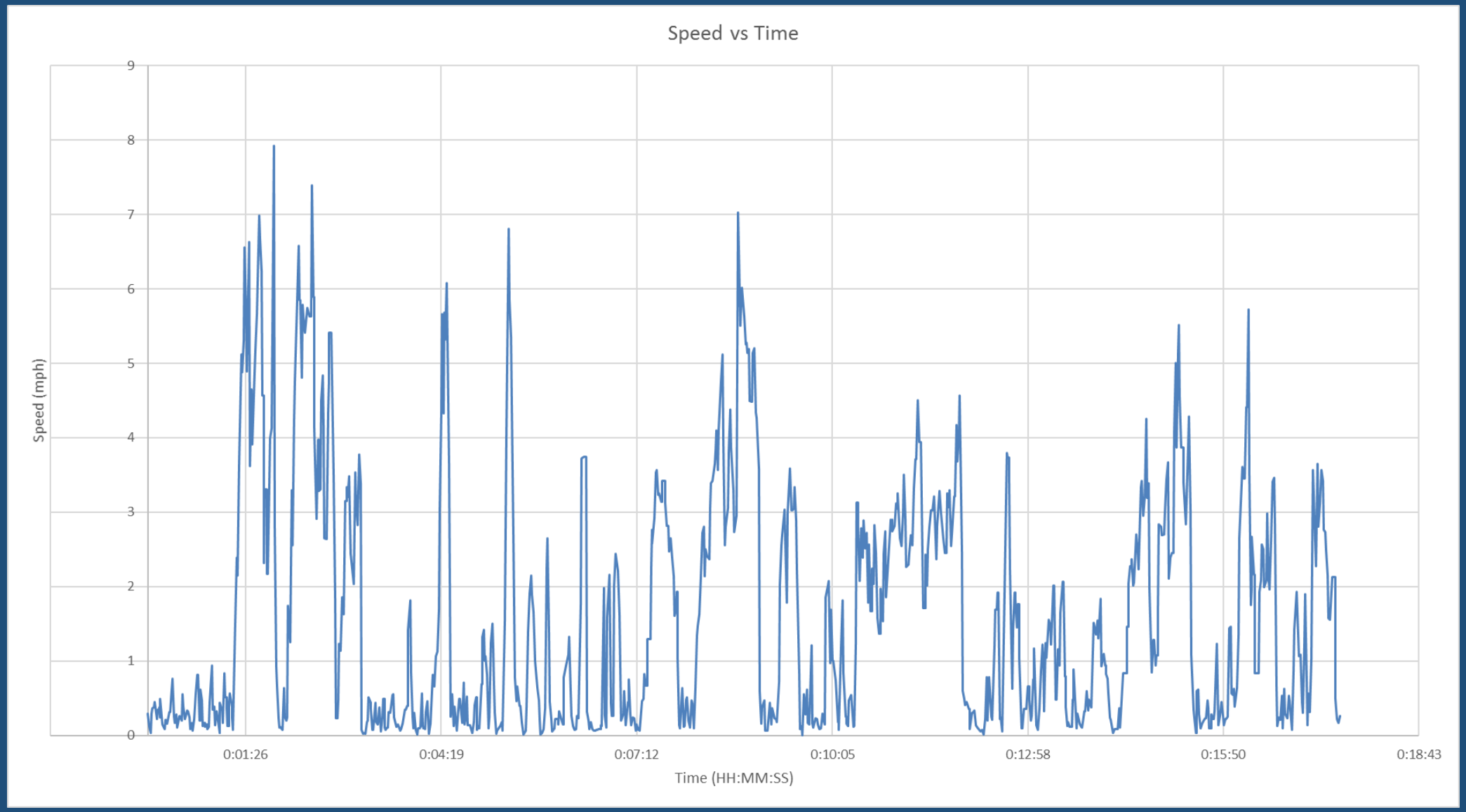
- Calibrate sensors
- Activate recording
- Monitor battery health
- Set constants such as map length and video links

COMPETITION DAY

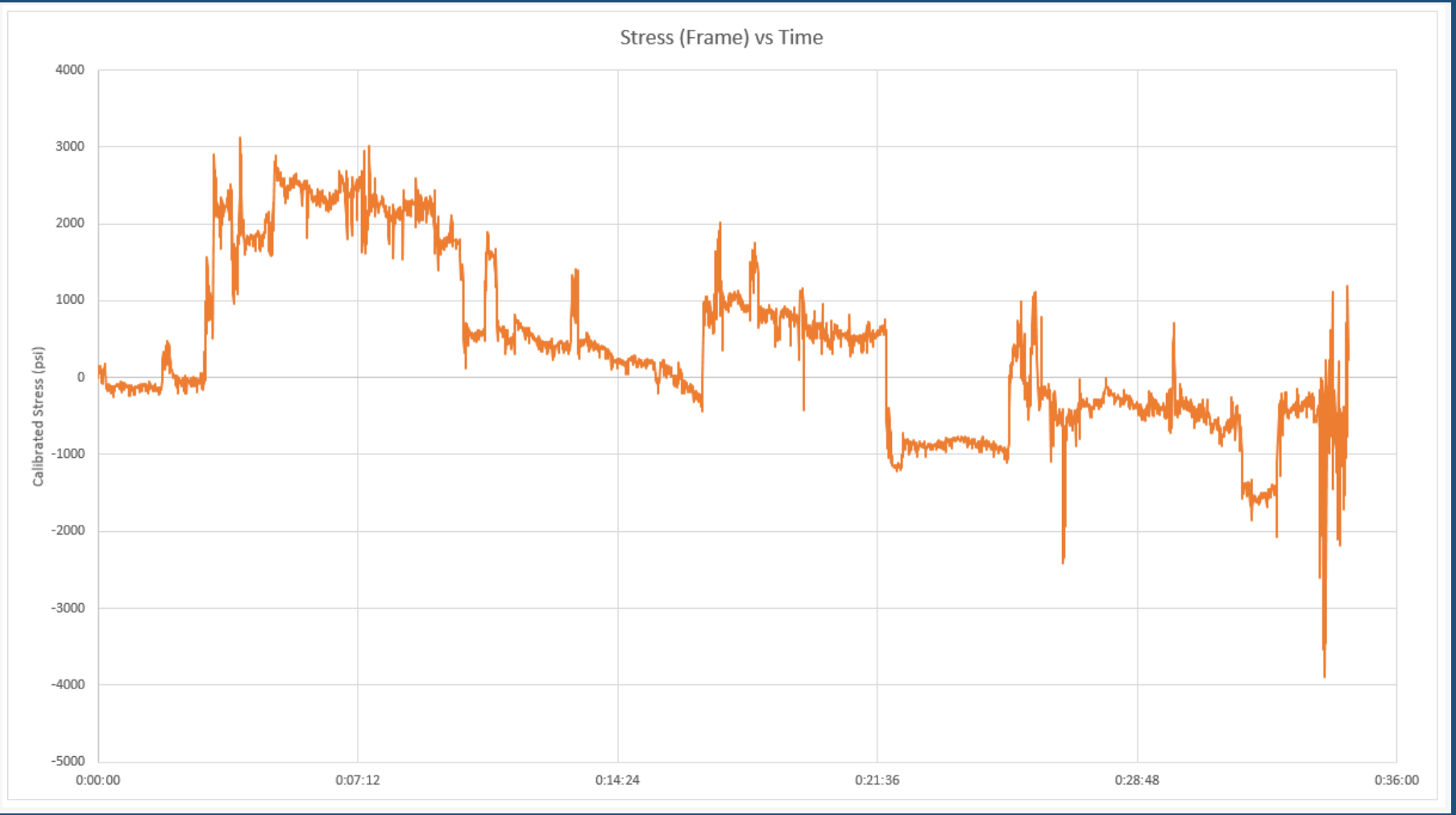
COMPETITION DATA



COMPETITION DATA



COMPETITION DATA



COMPETITION DATA

That's good & all,
But there's a better way
to represent this data…

COMPETITION DATA – Via Google Earth

COMPETITION DATA – Via Google Earth

COMPETITION DATA – Viewing Data

- Each data set can be viewed individually, or overlaid with other data sets as well

COMPETITION DATA – Viewing Data

- Specific events can be viewed right at their point on the course. Here is Acceleration in the Y-axis (Forward) at the infamous "Martian Butte"

ROVER

Questions?

APPENDICES

MOBILE SCIENCE PLATFORM SENSORS

Design Requirements	Rationale	Weighted Input
Heart Rate	Track driver biometrics and use in calculating the efficiency of the pilots' outputs	2
Temperature	Simulate actual data that a mission control might want to know	3
Barometric Pressure		3
UV Index		3

MOTION, LOCATION, ORIENTATION

Design Requirements	Nominal Input Value	Tolerance	Rationale	Weighted Input
Rover Velocity	1 mph Resolution	MIN RESOLUTION	To use to determine work input and to compare rover dynamics to stress (primarily when encountering obstacles)	8
Rover Acceleration	Present	N/A	To use for navigation and stress calculations	7
Rover Heading/Orientation	+/- 30 deg	MIN RESOLUTION	To track rover orientation during different obstalces on the course	9
Geolocation	4m Resolution	MIN RESOLUTION	To track rover position throughout course (4m resolution keeps us with the course width)	9

CAPTURE RATES

	Sensor Type	Refresh Rate	Rationale	Weighted Input
High Capture Rate: Performance Data	Stress Readings	100 Hz	Faster refresh rates allow us to see any spikes that occur	7
	Rover Acceleration	10 Hz		6
	Drivetrain			6
	Rover Angular Velocity			6
Medium Capture Rate	Rover Location	1 Hz	We do not anticipate any major change events of this data type more frequently than once per second.	6
	Rover Heading			6
	Heartrate			5
Slow Capture Rate: Environmental Data	UV Intensity	1 sample/min	We do not anticipate any major change events of this data type more frequently than once per minute.	3
	Temperature			3
	Barometric Pressure			3

All capture rates are indicated as minimum acceptable

Image Source
https://www.raspberrypi.org/wp-content/uploads/2015/08/raspberry-pi-lo

GROUND STATION

Design Requirement	Rationale	Weighted Input
Visual Feedback to Rider	For ground crew to act as a co-driver and provide pace notes	3
Wireless Video Feed	Requirement of Competition	10
GUI	Raw Data is Required, GUI to make it intelligible	10
Online Dashboard for Public Viewing	Would allow viewing dashboard over internet	3
Data Replay of Recorded Race Data	Useful to review parameters from previous course runs	2

HARDWARE

Design Requirement	Nominal Input Value	Tolerance	Rationale	Weighted Input
Max Weight	5 lbs for Total On-Rover Modules	MAX	Based on previous telemetry entries	5
Battery Life	1 hour	Min	To survive through complete competition	7
Module Enclosures	Target Equivalent to IP54	MIN	For environment-proofing the electronics	7
Transferable Components - Swap and Set-up Time	15 min	MAX	Any components that are designed to be swappable between rovers can be swapped in 15 mins	2

MECHANICAL DATA

Design Requirements	Nominal Input Value	Tolerance	Rationale	Weighted Input
Stress on components	1/20th of Material Yield Resolution	MIN RESOLUTION	Observe stresses rover encounters throughout the course and to verify the rover design expectations	9
Drivetrain Angular Velocity	Present	N/A	To use in calculating the work output by the pilots	9
Drivetrain Torque	5 ft·lbs Resolution	MIN RESOLUTION	To use in calculating the work output by the pilots	9