Using Intel® Edison to Fuse Embedded Linux with Existing Drone Flight Controllers

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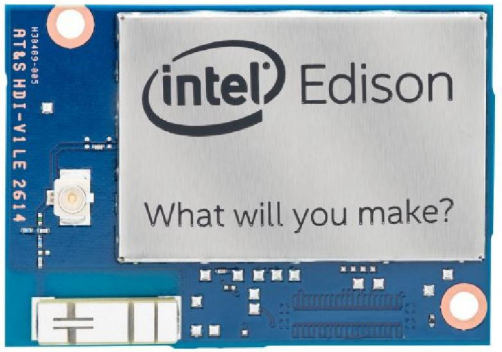
Motivation

- Build an extensible drone platform on top of an existing Low Level Flight Controller

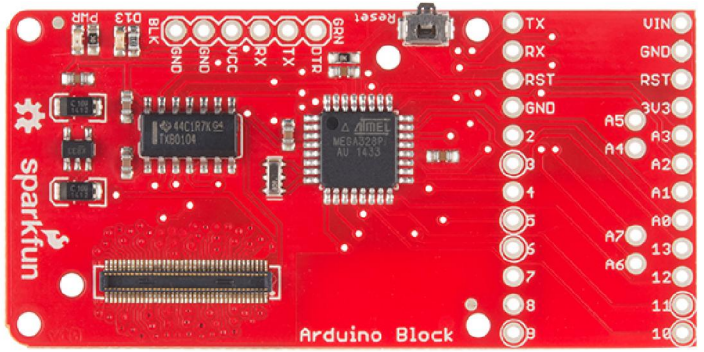
What is Edison?

- Compute Module
- Atom Silvermont
- Dual Core 32-bit 500MHz
- 1GB RAM, 4GB eMMC
- Wi-Fi (802.11a/b/g/n), BT 4.0
- 70-pin Hirose Connector
- Quark 32-bit 100MHz Processor

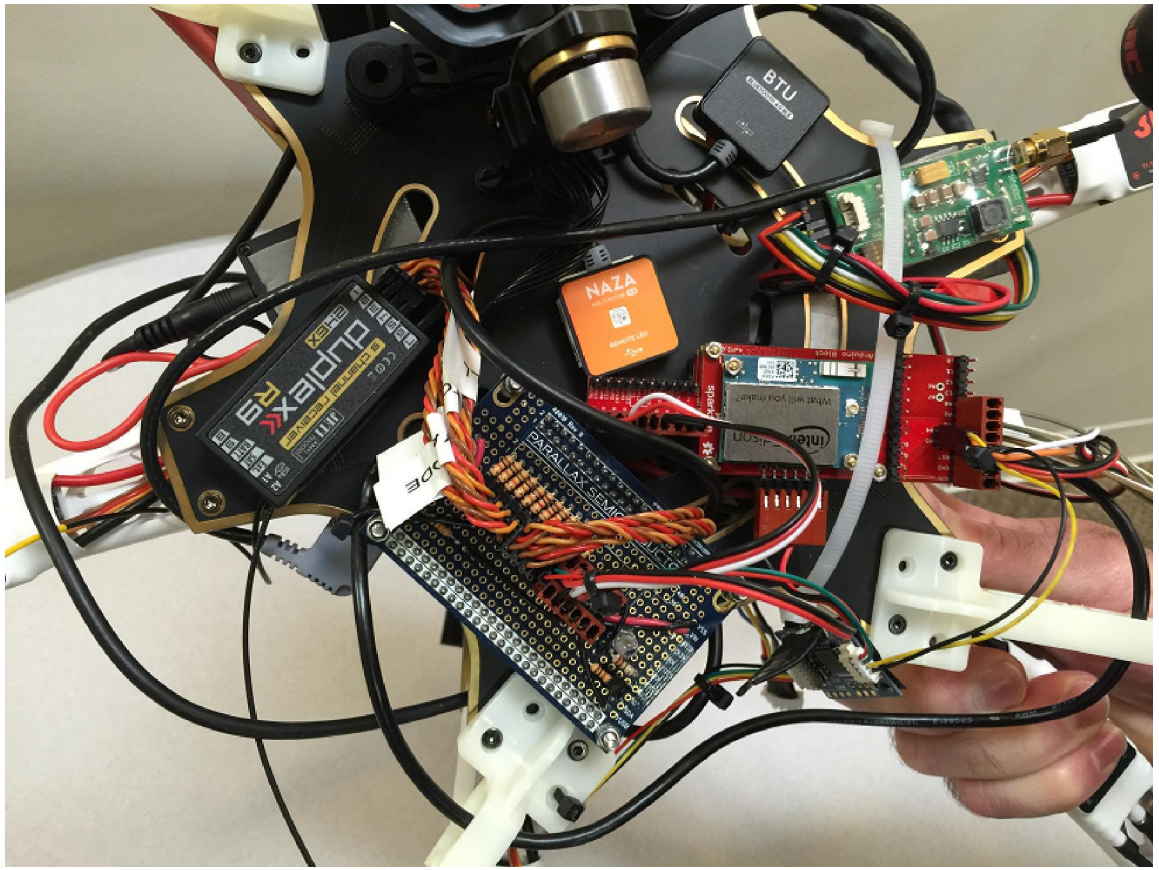


Why Edison?

- Integrated Wireless Connectivity
- Small Form Factor (35.5 x 25 x 3.9 mm)
- Low Power Design
- Processing Power
- Stackable Design

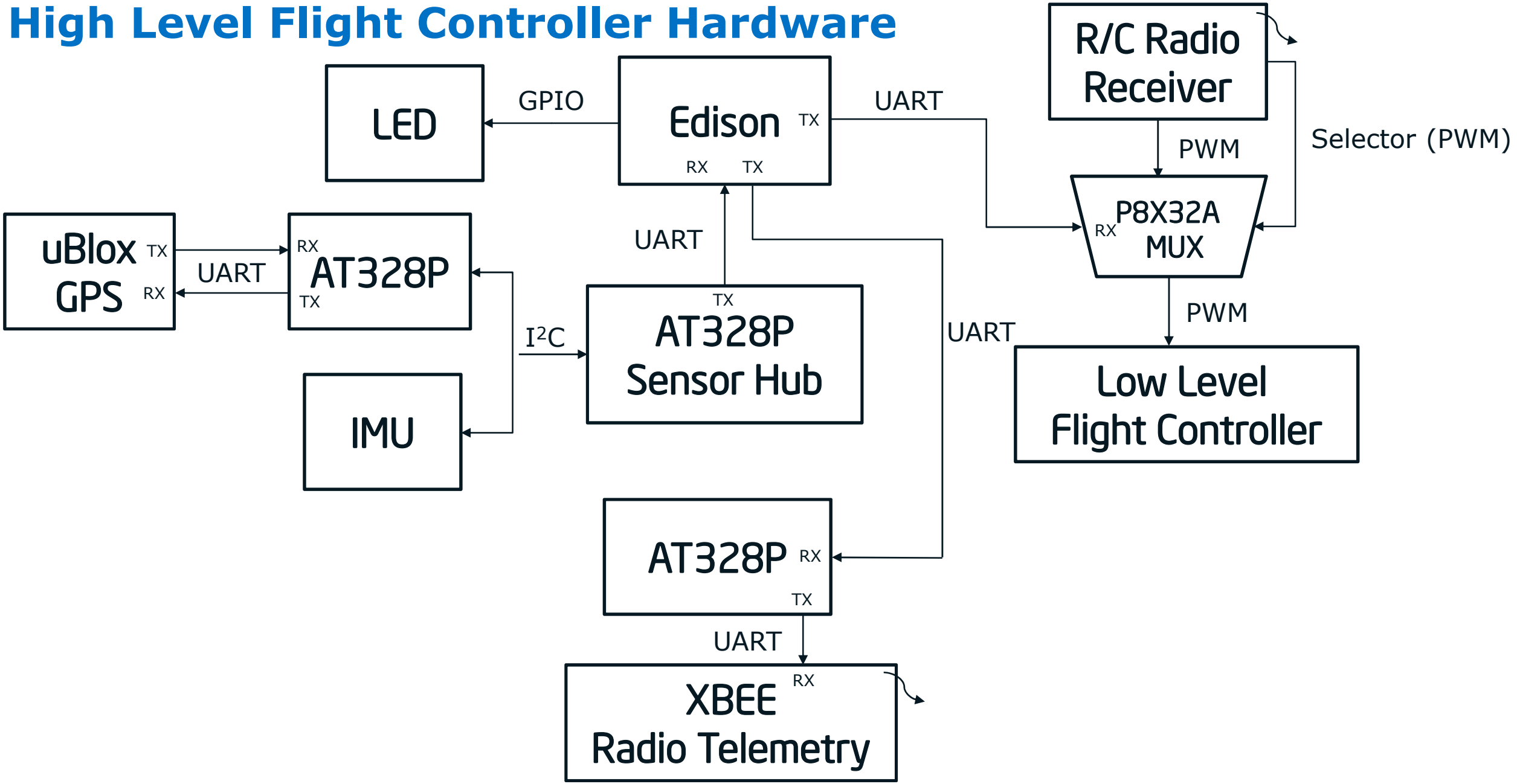


Multirotor Drone



Multirotor Drone

High Level Flight Controller Hardware

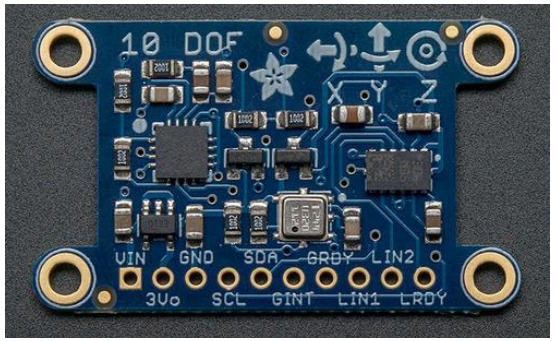


Software Stack High Level Flight Controller

- Yocto Project Based Distribution
- Runs on Edison
- Reads waypoint mission data and commands from web server
- Reads sensor data from sensor hub
- Computes bearing to target
- Generates output to control desired throttle, pitch, roll and yaw
- Transmits output to LLFC via MUX
- Logs data to file system + transmits telemetry via radio

Sensor Hub

- Atmel ATMega 328P
- ADAFruit 10-DOF IMU
  - 3 axis Accelerometer
  - 3 axis Gyroscope
  - 3 axis Magnetometer
  - Barometer
- uBlox GPS
- Retrieves sensor data via I^2C
- Transmits serial packet to Edison

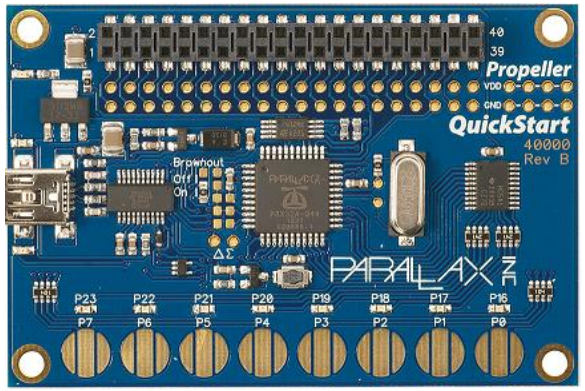


GPS Serial to I²C Converter

- Atmel ATMega 328P
- uBlox 6M
- Initialize GPS module 5Hz at 57600 Baud
- Format GPS serial data to single packet
- Convert to I²C for Sensor Hub

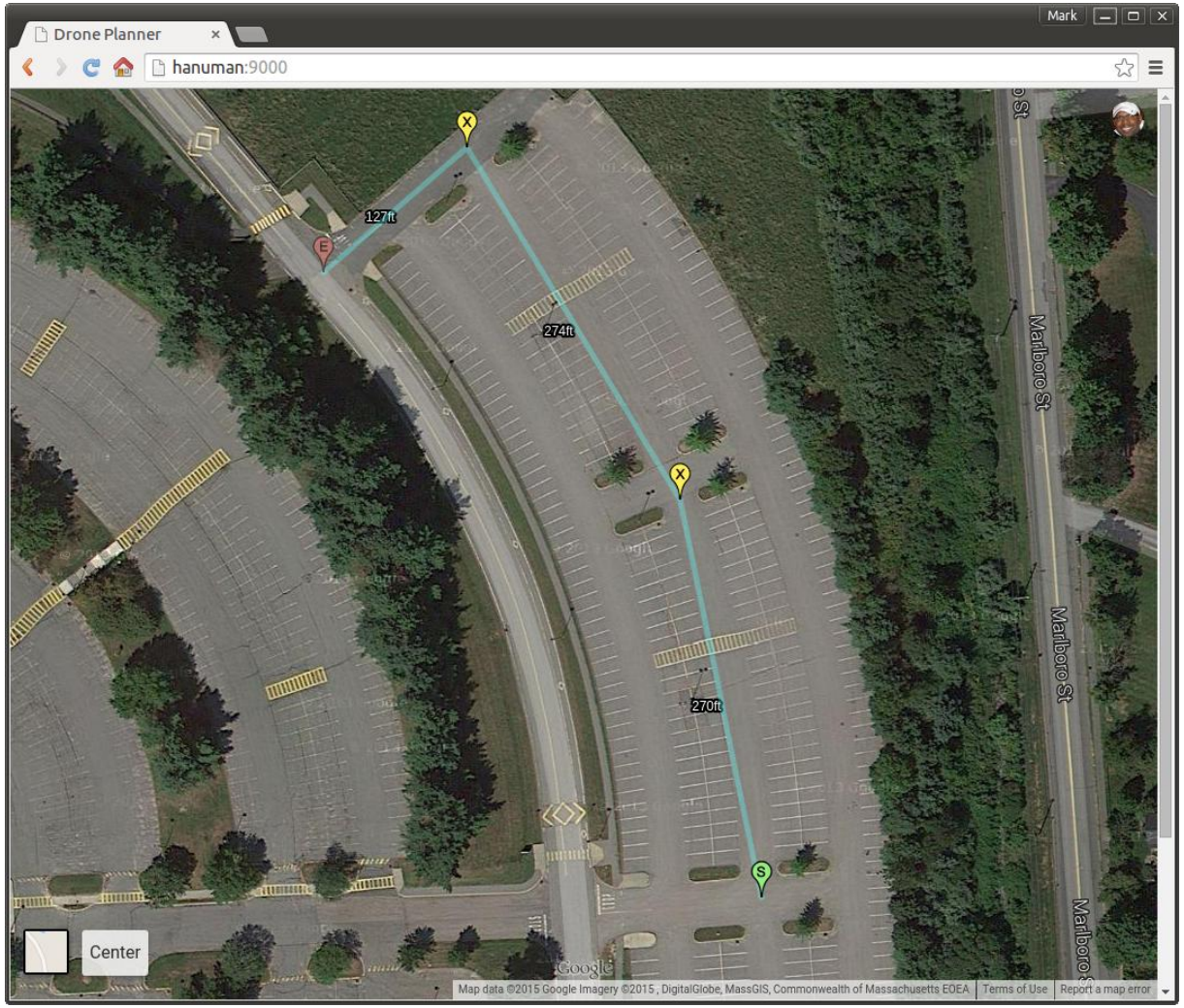
MUX

- Propeller P8X32A
- Multiplexes:
  - Serial Commands from Edison
  - R/C RX inputs
    - MUX selector
    - Manual stick inputs (flight controls & bailout)
- Outputs PWM to Flight Controller

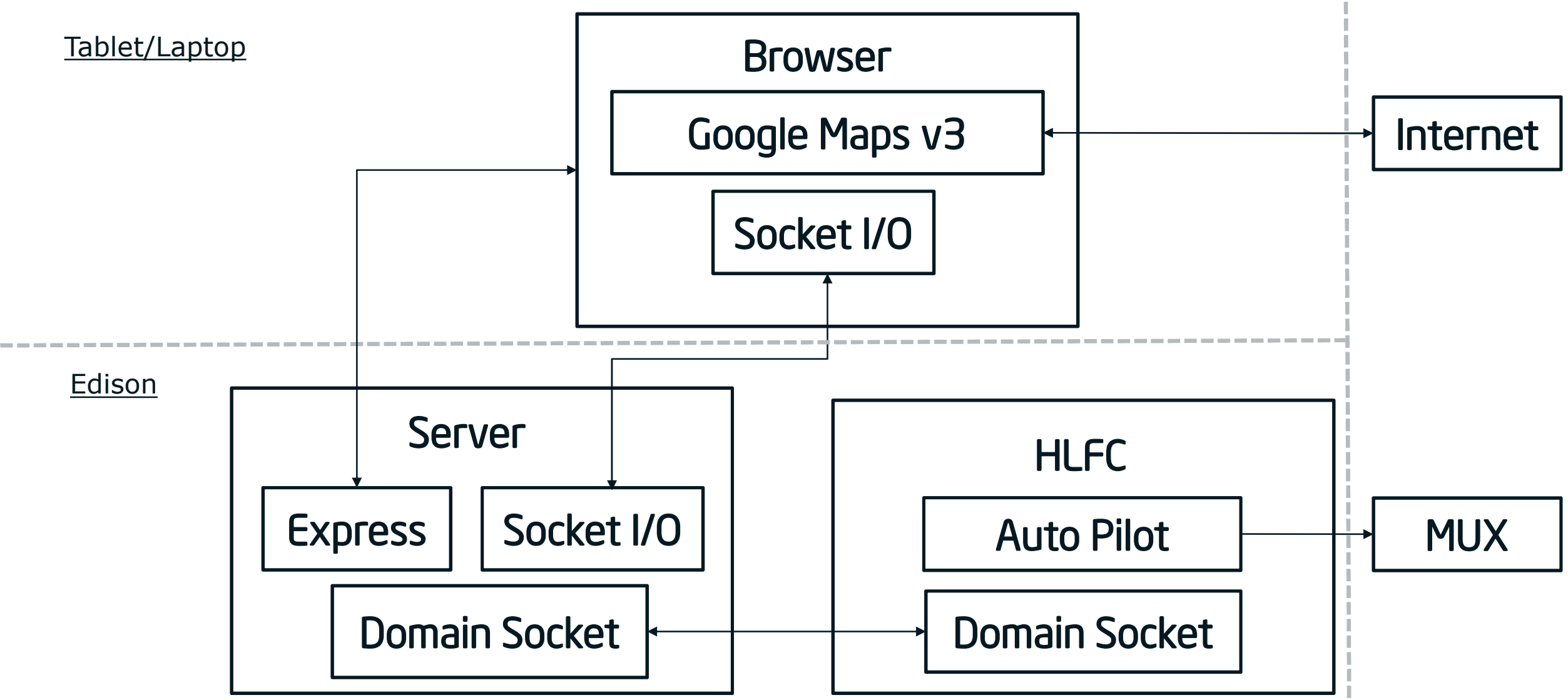


Navigation Planner

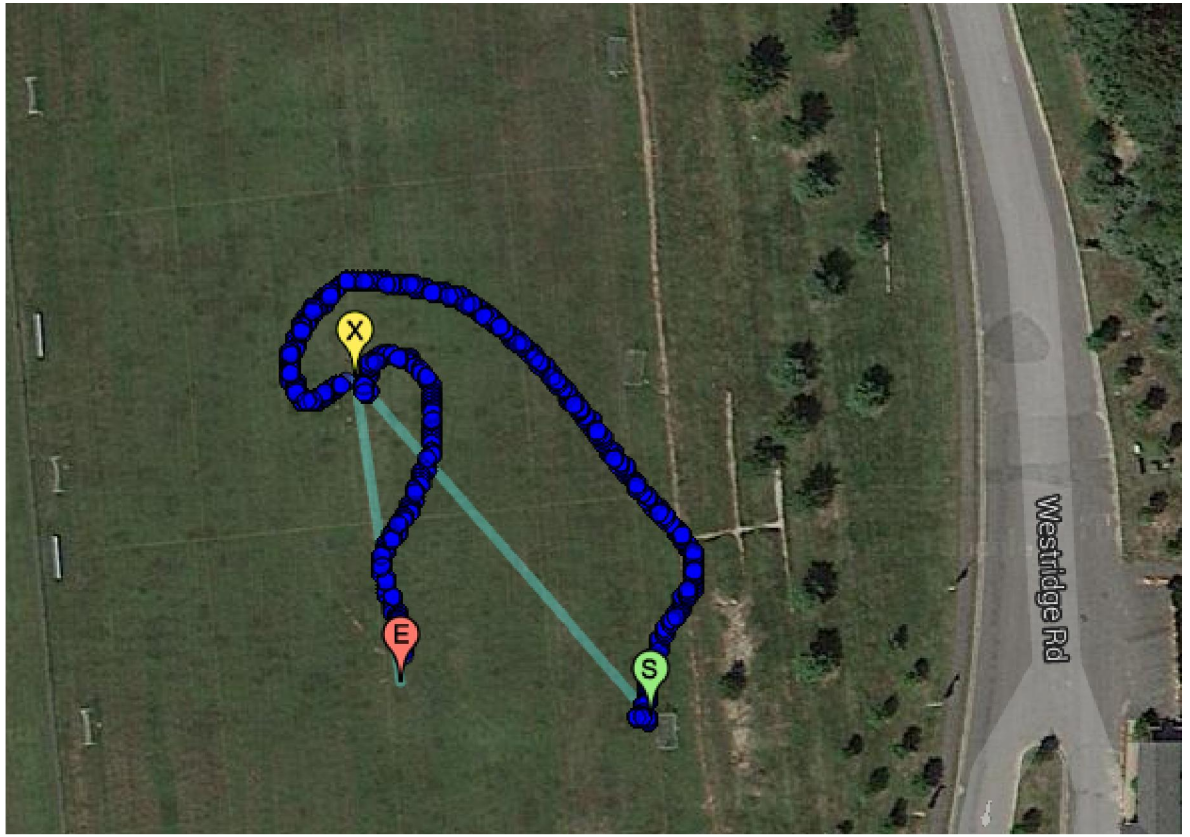
- Webserver on Edison
- node.js
  - Express
  - Socket I/O
- Arduino
- Google Maps v3 API
- Telemetry
- Waypoint Support



Navigation Planner Software Layout



Telemetry Visualization



Results (Highlights)

- Altitude Testing
- Yaw Testing
- Waypoint Navigation
- GEO Fencing
- Telemetry Data Visualization
- Bailout/Safety Switch
- GPS accuracy
- Short Development Time

Results (Pitfalls)

- Sensor Problems
  - Magnetometer
  - Barometer
  - Signal Noise
- Software Problems
  - Node.js error handling
  - Arduino IDE issues
  - Toolchain
  - File Syncing
  - Boot time

Results (Pitfalls Continued)

- Board Level Problems
  - Lack of Power Domain Control
  - Power Supply Noise
  - I/O Voltage Level Conversion

What is Next?

- Board Level Optimizations
- Navigation Tightening
  - Better Heading Estimation
  - Improved Flight Speed
  - Flight Simulation
- Object Detection, Avoidance, Following
  - Vision System
  - Terrain Avoidance

What is Next? (Continued)

- Drone Code protocol support
- Leverage Quark/RTOS
- Cellular Modem (Internet Connection)
- Weather Database Query En Route

Project Websites

- Project Page: (GitHub) http://goo.gl/hTVcDY
- YouTube Videos
  - Test Flight To Waypoint
    - https://www.youtube.com/watch?v=zwC07qLmMzQ
  - Test Flight Over Controlled Yaw
    - https://www.youtube.com/watch?v=OTQT48VxALY
- Edison Product Page
  - http://www.intel.com/content/www/us/en/do-it-yourself/edison.html

Special Thanks

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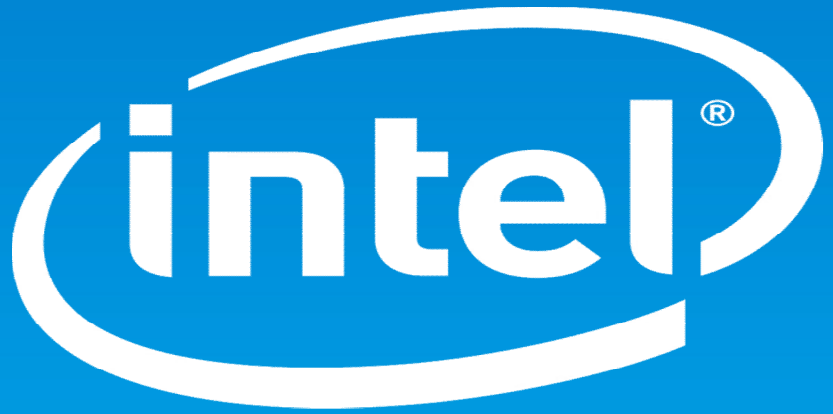
- Bill Porter, for EasyTransfer, http://www.billporter.info/2011/05/30/easytransfer-arduino-library/
- Adafruit's, Kevin Townsend, for the Sensor libraries, https://learn.adafruit.com/adafruit-10-dof-imu-breakout-lsm303-l3gd20-bmp180/software
- I.Kövesdi, for the Great Circle Distance and Great Circle Bearing calculation, http://obex.parallax.com/object/256

Questions?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