Fault-Tolerant Quadcopter

ECE 453 Project Proposal (Fall 2018)
University of Wisconsin-Madison

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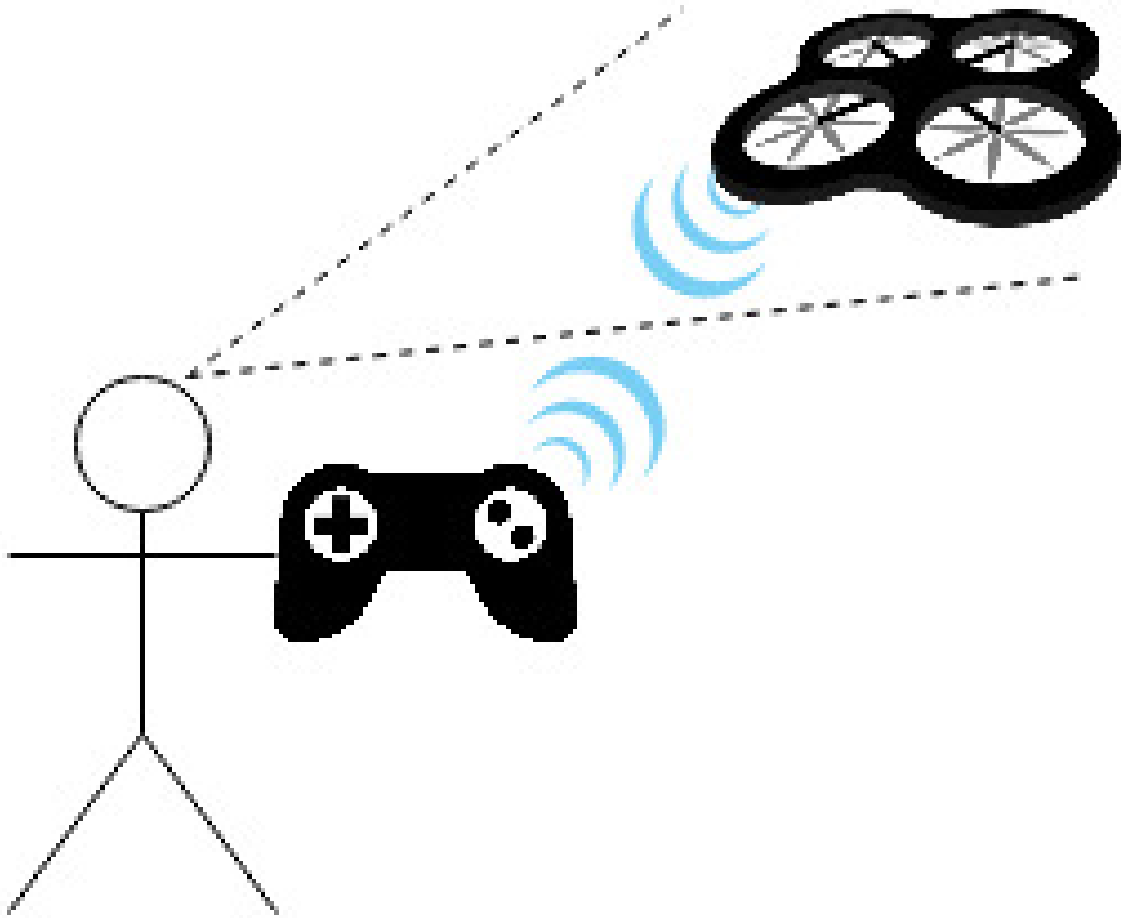
State of the Art (Cheap Toys)

LOS Required, Virtually no health / status telemetered



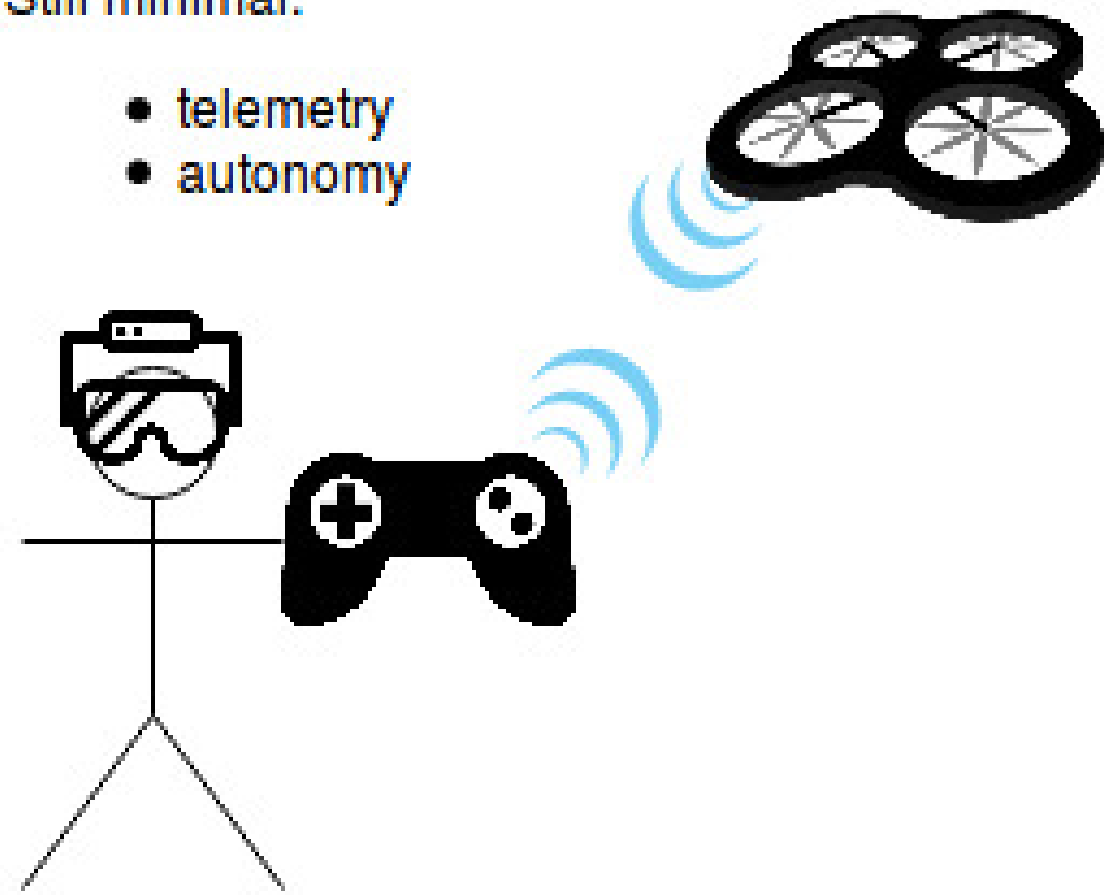
Price Range: $25 - $50

State of the Art (Enthusiast FPV)

LOS "not required" for operator (still ~required for radio)

Still minimal:

- telemetry
- autonomy



Price Range: $100+

State of the Art (Industry)

Light Show at the Olympics

State of the Art (Industry)

Intel Surveys Great Wall of China

Problem Statement

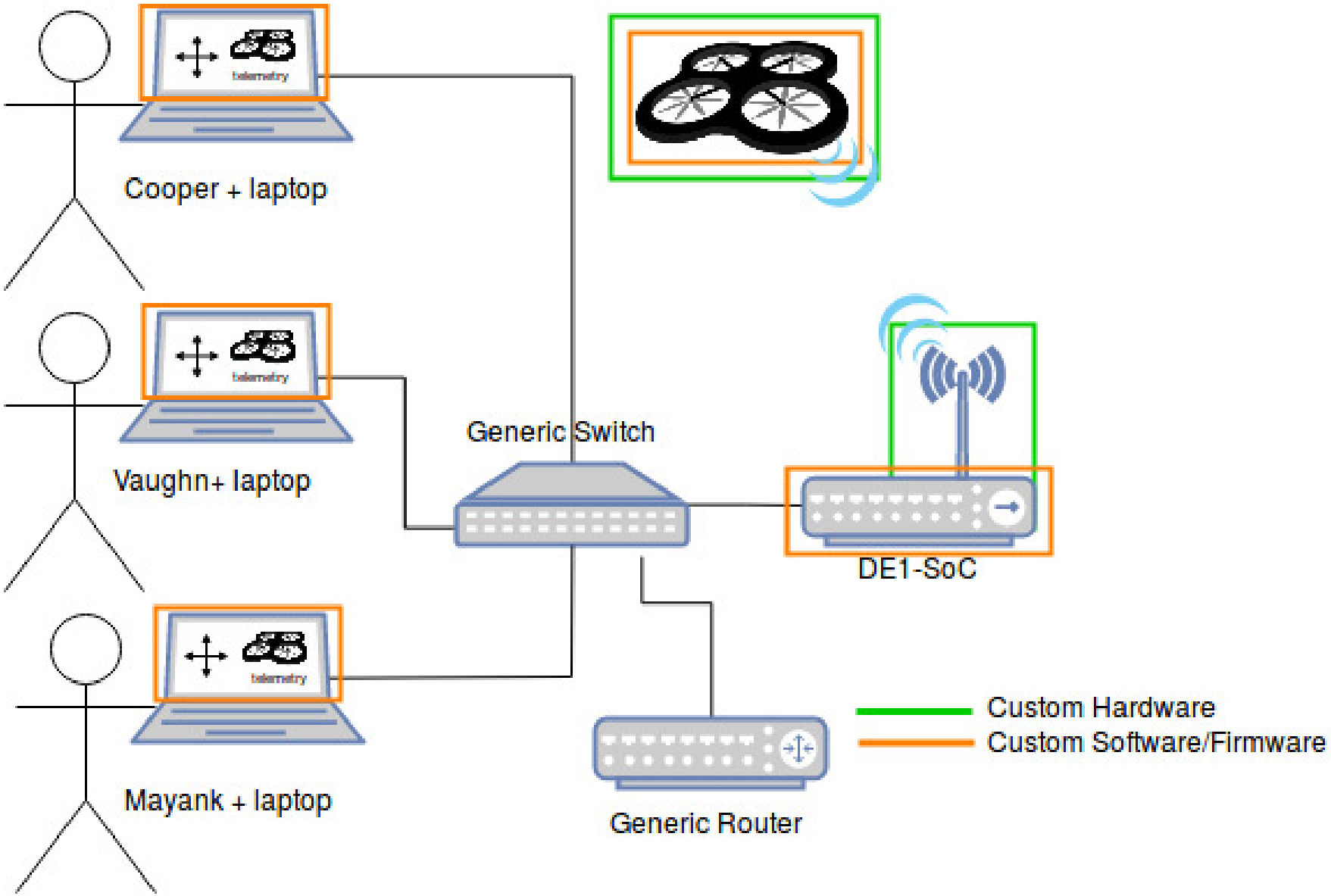
No "multi-vehicle fleet" or autonomous-flight capable drone technology available to interact with.

What gap can we fill in this ecosystem?

To gain experience with aerospace-related problems, we propose designing, testing and building a custom flying machine.

How hard are these problems?

Concept of Operation



Features

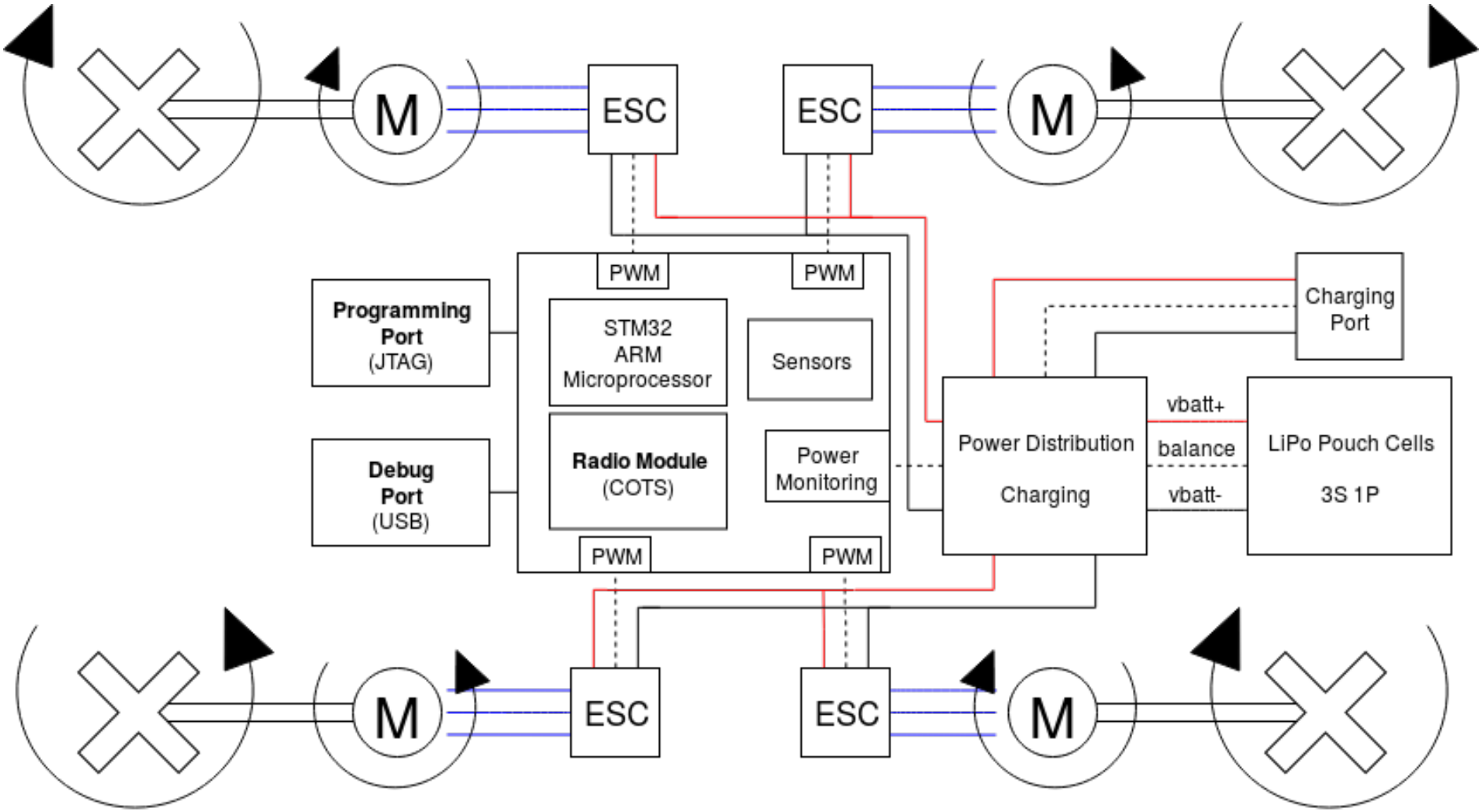
Telemetry Viewing – View vehicle data from the UI

Manual Commanding – Control the vehicle from the UI

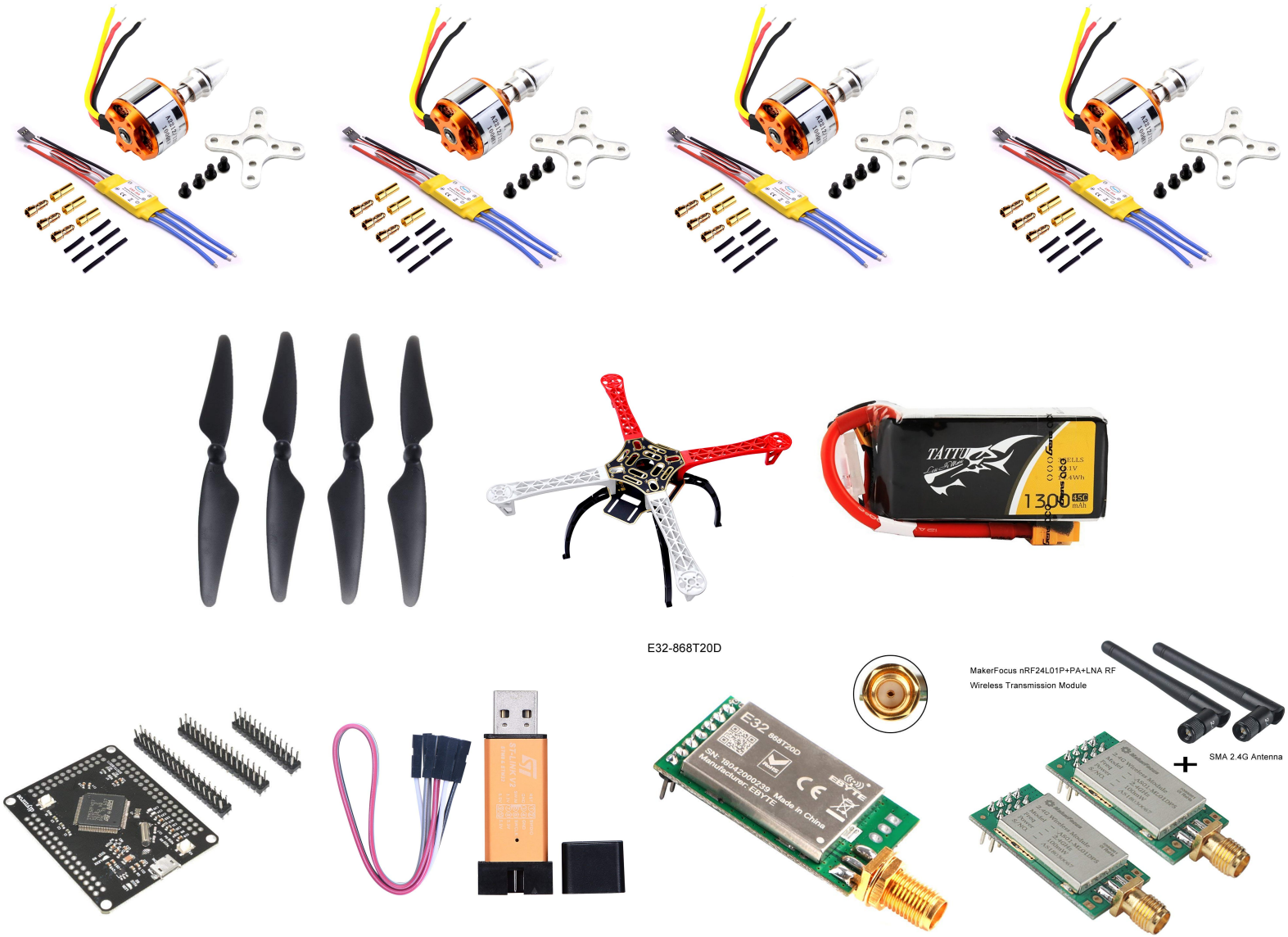
Holding-Pattern Stability – Ability to "idle" with little to no motion

Single-Fault Tolerant – Land safely if communication is lost

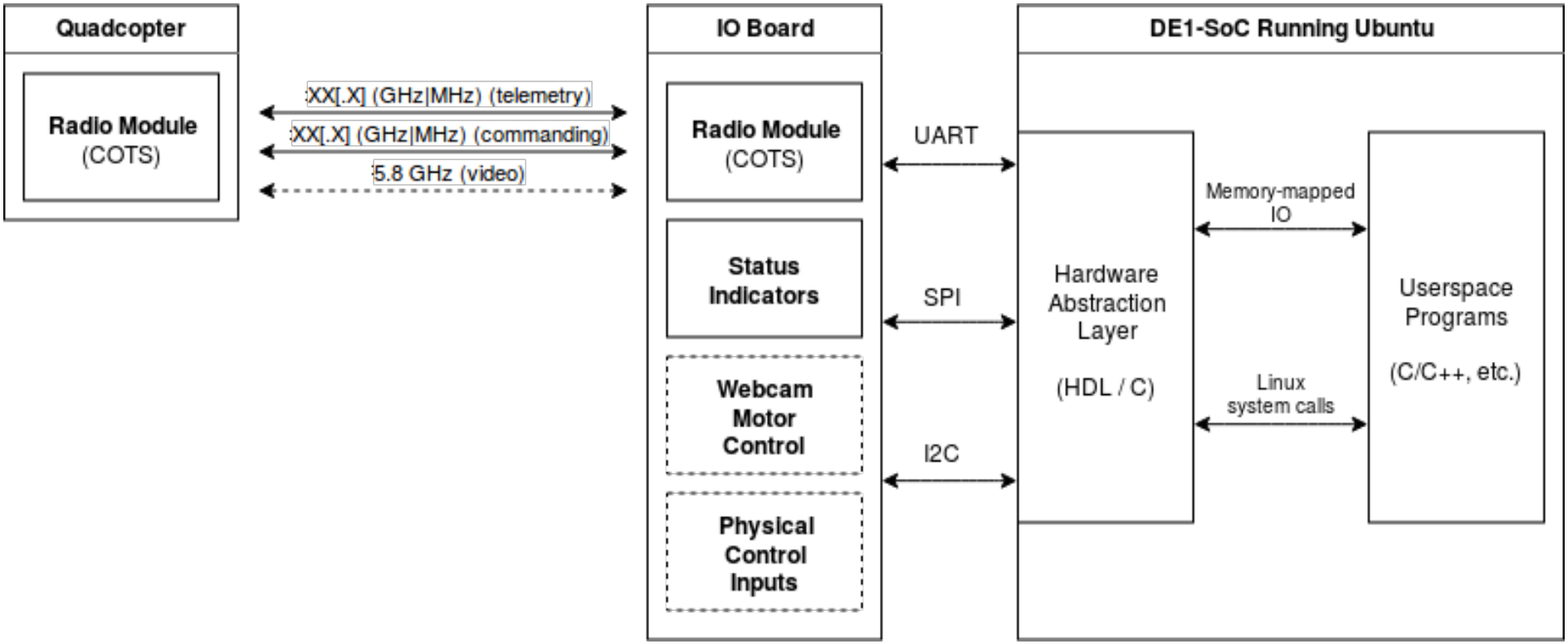
Quadcopter


M
ESC
ESC
M
PWM
PWM
Programming Port (JTAG)
STM32 ARM Microprocessor
Sensors
Charging Port
Debug Port (USB)
Radio Module (COTS)
Power Monitoring
Power Distribution
Charging
vbatt+
balance
vbatt-
LiPo Pouch Cells
3S 1P
PWM
PWM
M
ESC
ESC
M

Quadcopter Components



Ground Station



User Interface

API Commands (A)

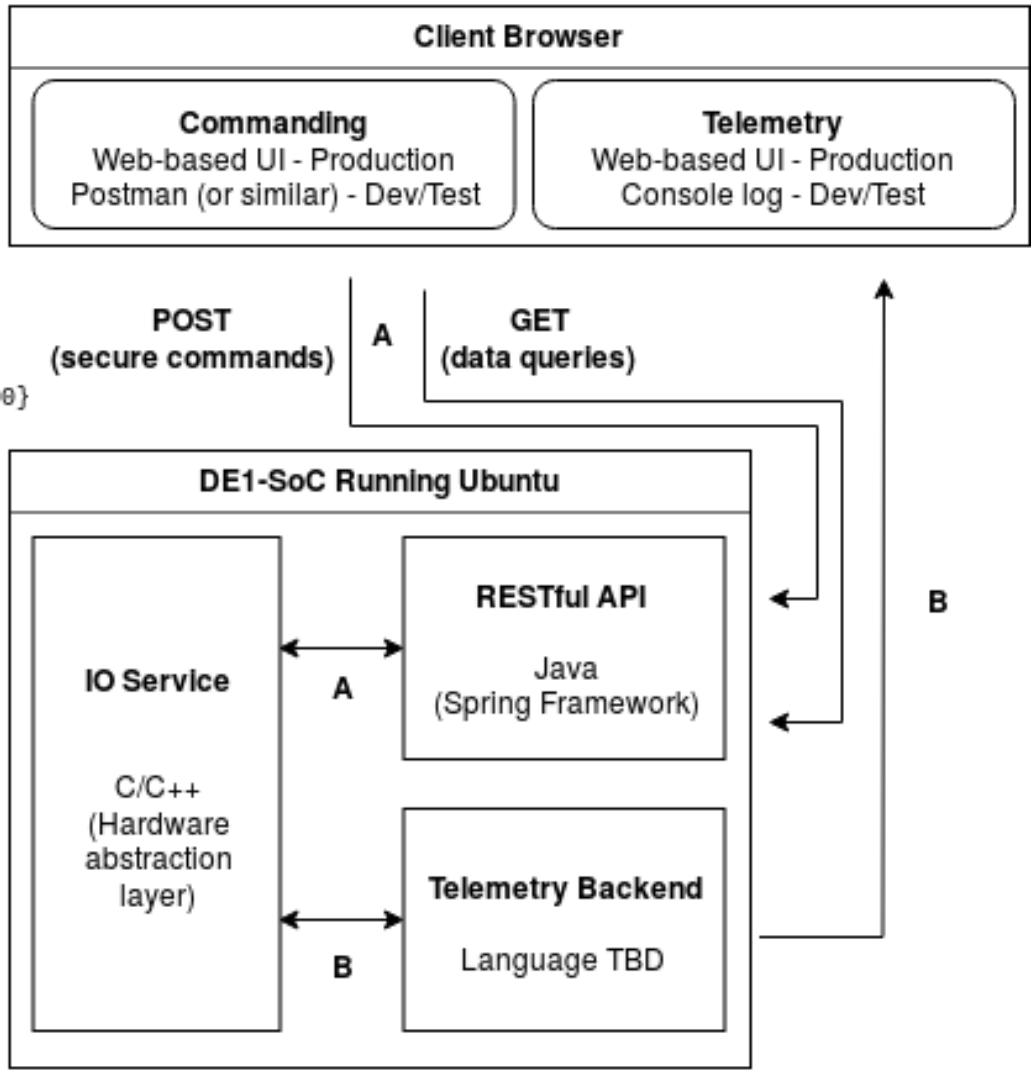
HTTP over TLS

```
https://host/move/up/{0 - 100}
https://host/move/down/{0 - 100}
https://host/move/left/{0 - 100}
https://host/move/right/{0 - 100}
https://host/move/forward/{0 - 100}
https://host/move/back/{0 - 100}
https://host/move/rotate/{-100 - 100}
...
```

Telemetry Data (B)

Secure WebSocket

```
telemetry_packet {
  timestamp: 1536646557,
  age: 15,
  type: "sensors",
  data: [
    temperature: 22,
    pressure: 101325,
    gyro: {
      rate_xy: -1,
      rate_xz:  2,
      rate_yz: -3
    }
    ...
  ]
}
```



Inter-process communication over local-loopback socket streams (TCP)

Estimated Total Cost

$305 – Quadcopter (Parts, custom PCB)
$108 – Ground Station (Parts, custom PCB)
$200 – General development and test equipment/components
$613 – Total

Higher-granularity breakdown in report.

Summary

We feel prepared to take on this challenge:

- Prior experience with systems' engineering (vehicle projects)
- At least a dozen previous failures
- Confident in this architecture
- Have development tools and equipment on standby

Funding would greatly increase the quality of the final product!