

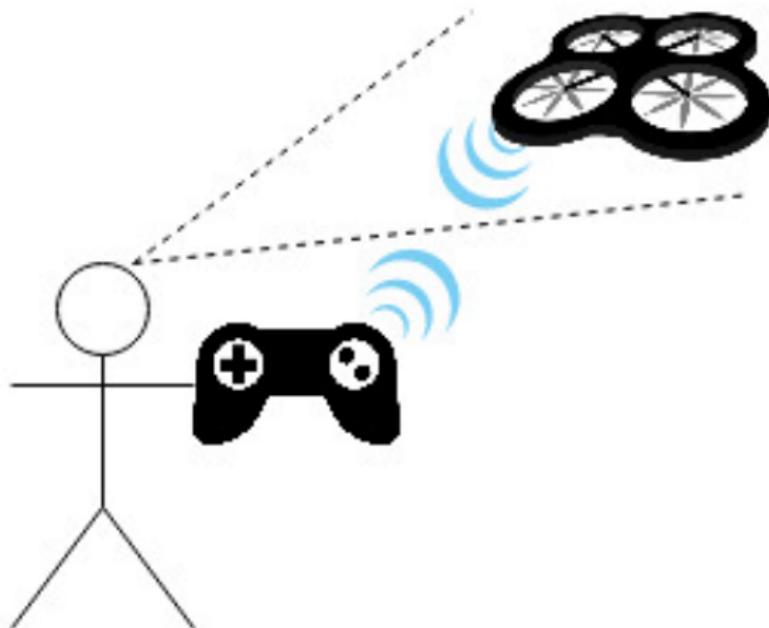
Fault-Tolerant Quadcopter

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



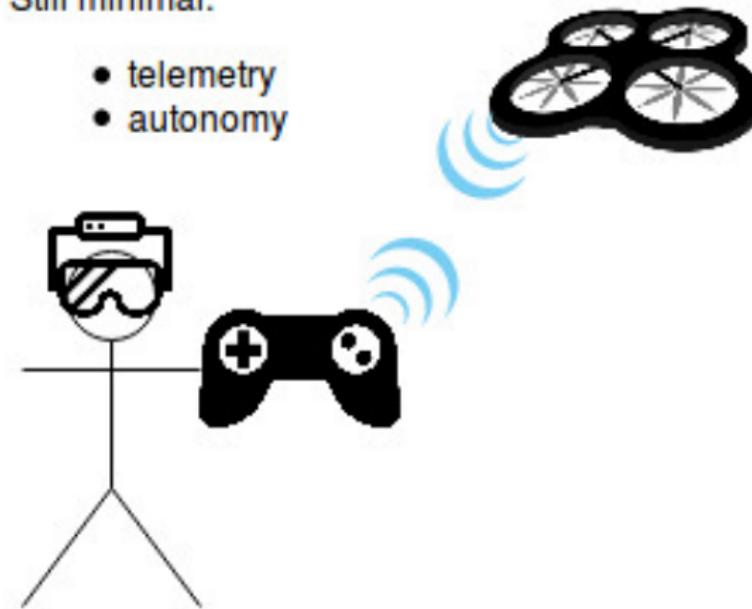
Price Range: \$25 - \$50

State of the Art (Enthusiast FPV)

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

Still minimal:

- telemetry
- autonomy



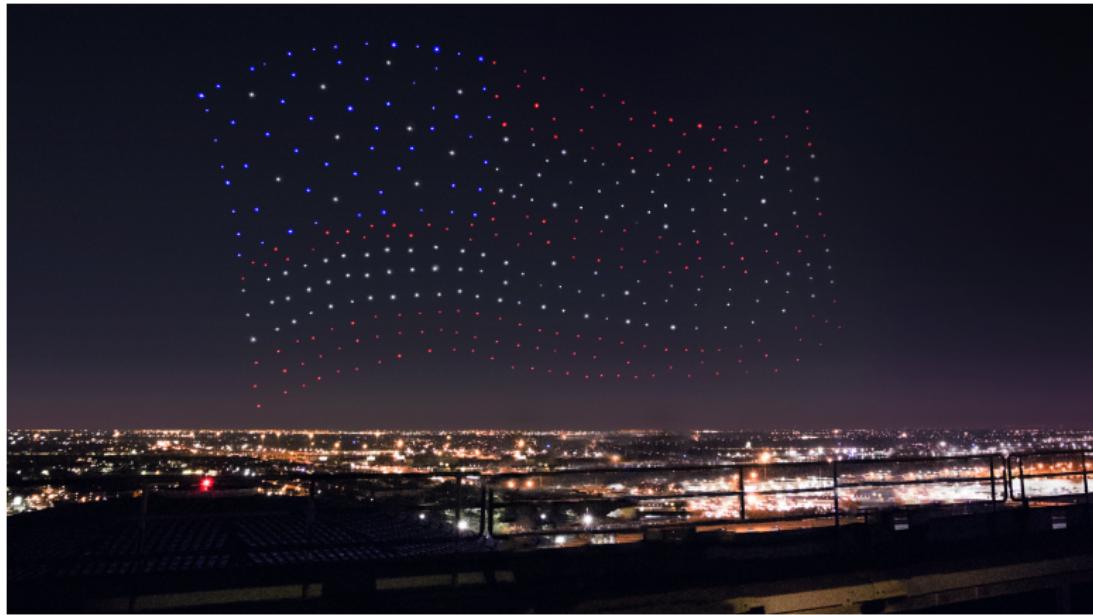
Price Range: \$100+

State of the Art (Industry)



Light Show at the Olympics

State of the Art (Industry)



Super Bowl LI Halftime Show

State of the Art (Industry)



Intel Surveys Great Wall of China

State of the Art (Industry)



Controlled via laptop

Problem Statement - Relevance

Seemingly no “multi-vehicle fleet” or autonomous-flight capable drone technology is available to interact with in the consumer market.

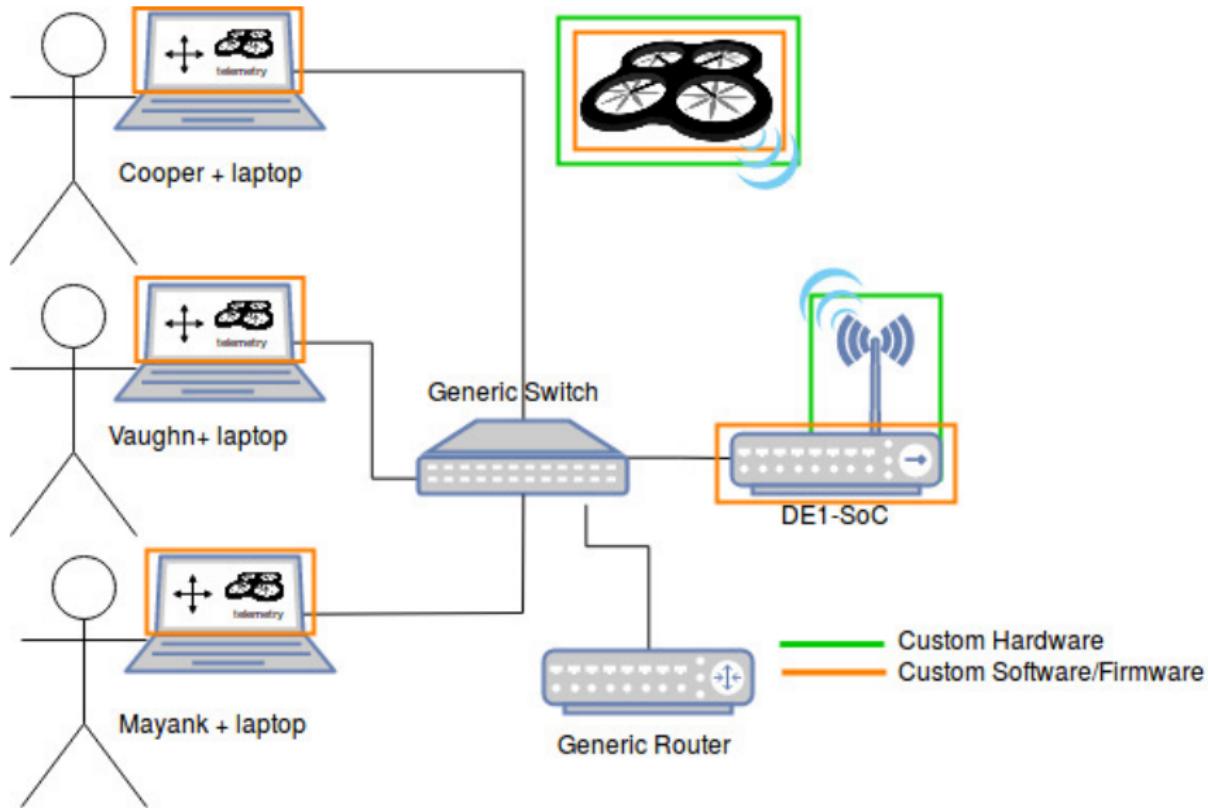
We gap can we fill in this ecosystem?

Problem Statement - Motivation

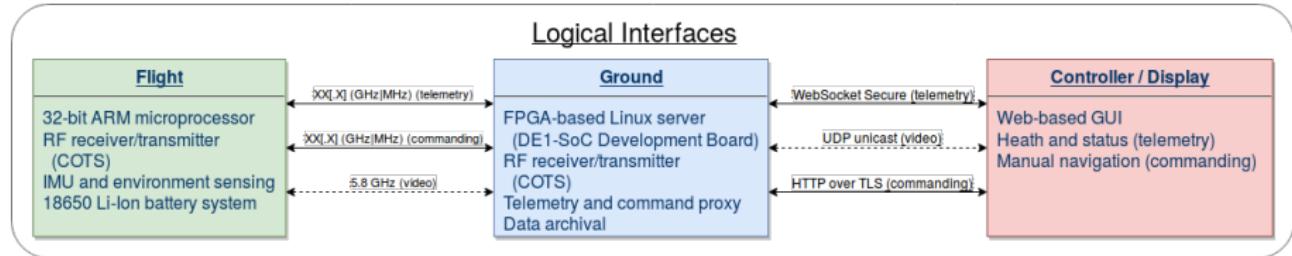
To gain relevant experience with aerospace problem spaces, it's necessary to design, test and build a custom flying machine.

How hard are these problems?

Concept of Operation



Overview



Quadcopter – Battery-powered, four-motor flying machine

Ground Station – Linux server managing the quadcopter's radio endpoint, hosts wired-network services (i.e. telemetry)

Web-based UI – A modern dashboard for visualizing data and manually commanding the vehicle

Features

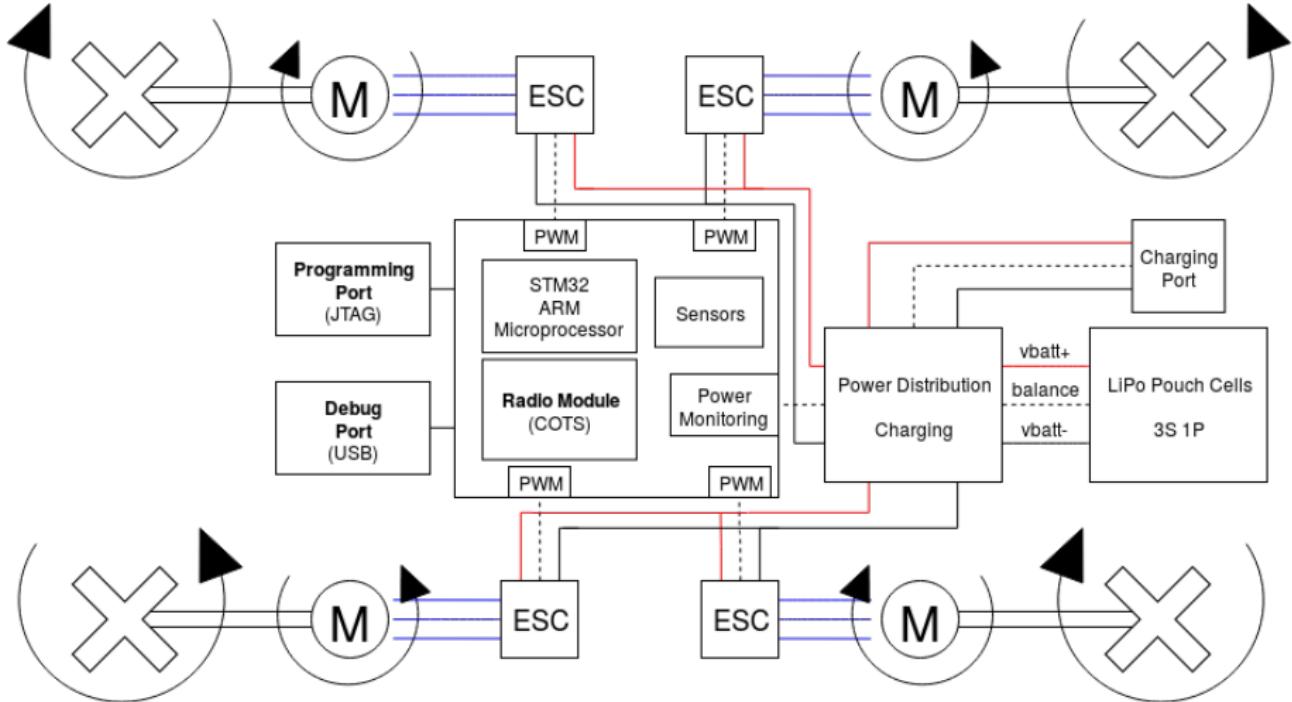
Telemetry Viewing – View vehicle data from the UI

Manual Commanding – Control the vehicle from the UI

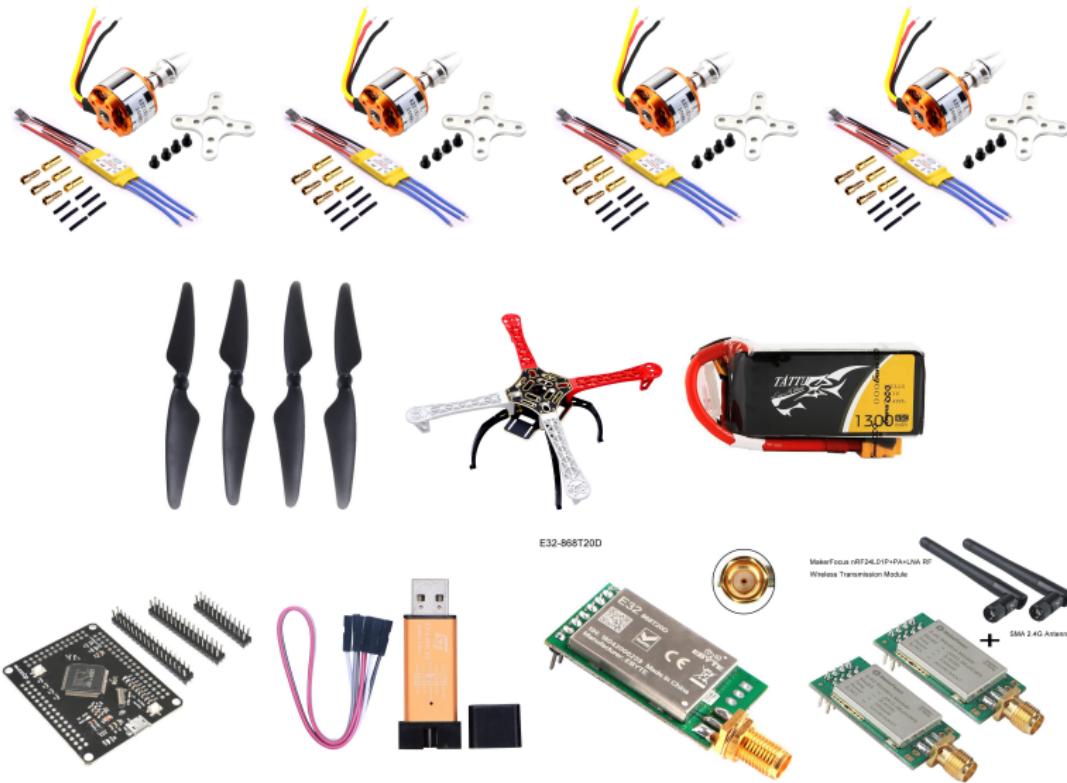
Holding-Pattern Stability – Ability to “idle” with little to no motion

Single-Fault Tolerant – Land safely if communication is lost

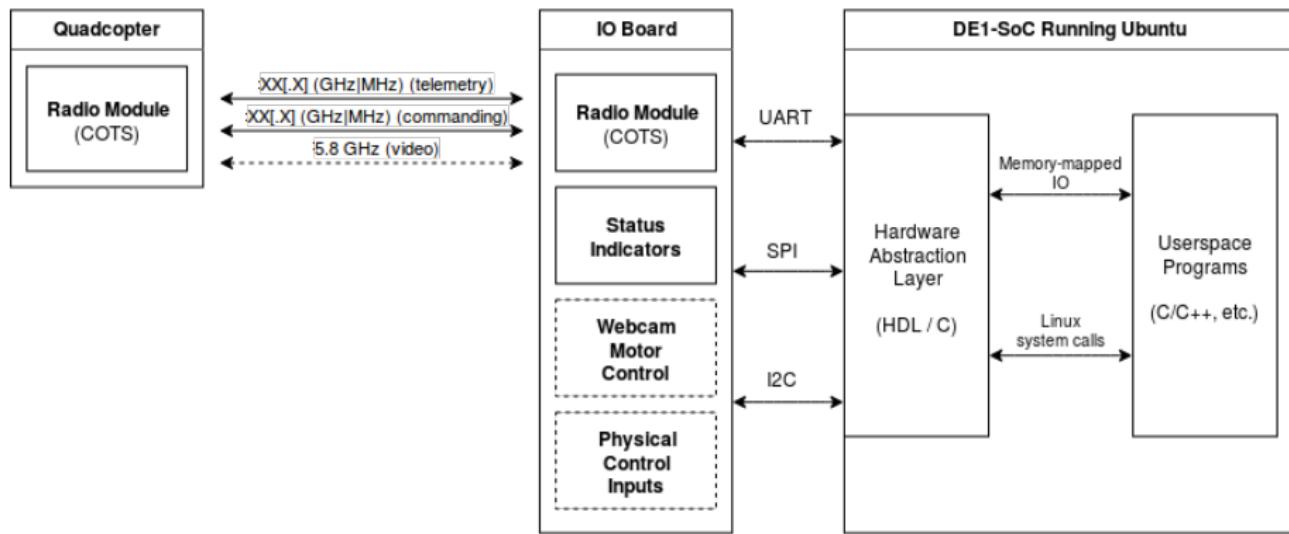
Quadcopter



Quadcopter Components



Ground Station



User Interface

API Commands (A)

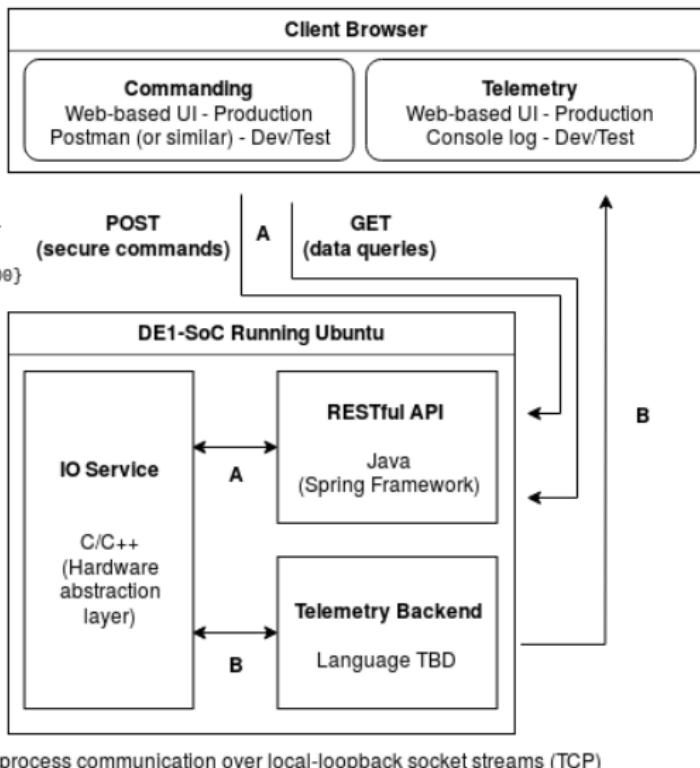
HTTP over TLS

```
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  
        }  
        ...  
    ]  
}
```



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!