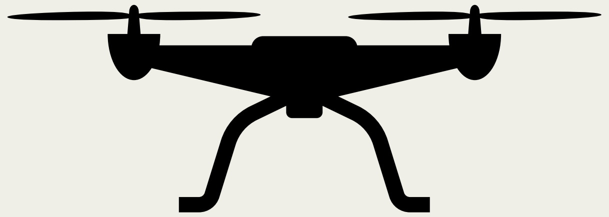
The Copilots 

SENIOR DESIGN PROJECT

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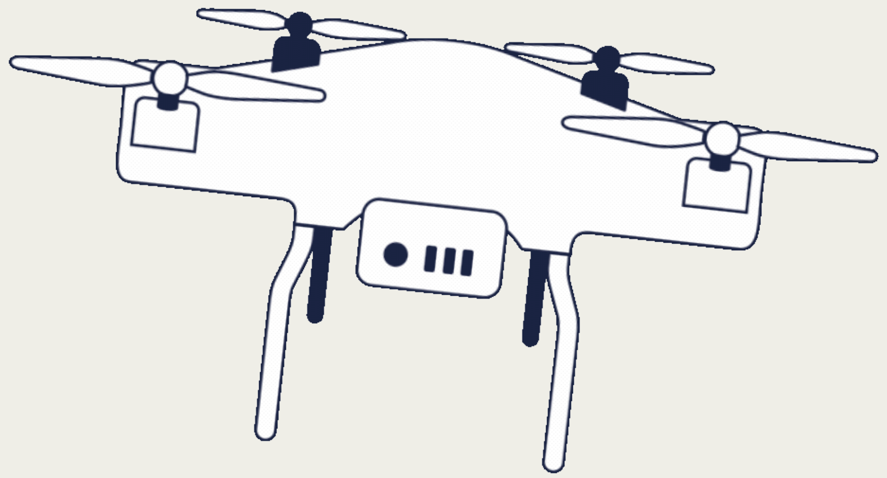
AGENDA

- Background
- Problem Formulation
- Solution Generation
- Top Solution Design
- Conclusion



BACKGROUND

- Natural disasters (earthquakes, floods, wildfires) have caused major damage and loss of life.

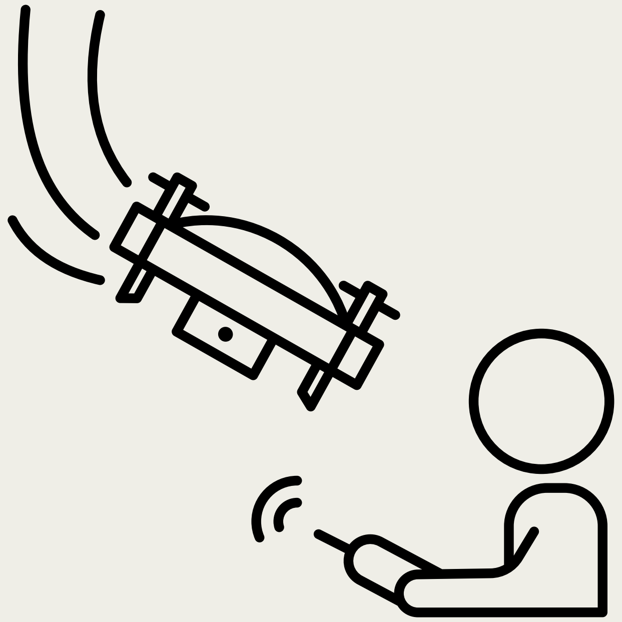
- There's a growing need for advanced technologies to improve disaster response, including search and rescue, supply access, environment mapping, and obstacle navigation.

- Robotics, especially autonomous ground and aerial systems like Quanser QBot 2 and QDrones, can effectively meet the challenges of disaster scenarios.

PROBLEM STATEMENT

In disaster zones, it is unsafe for people to travel. People need access to basic supplies like food, water and medicine which are not easily accessible. An autonomous vehicle system will enable scouting, navigation and easier delivery of supplies to such areas.

PRODUCT CONSTRAINTS



Environmental Constraints

- Noise Limit: Drone cannot exceed 85dB noise limit -
- Drone Speed: A maximum of 100 miles per hour (87 knots)

Socio- Cultural Constraints

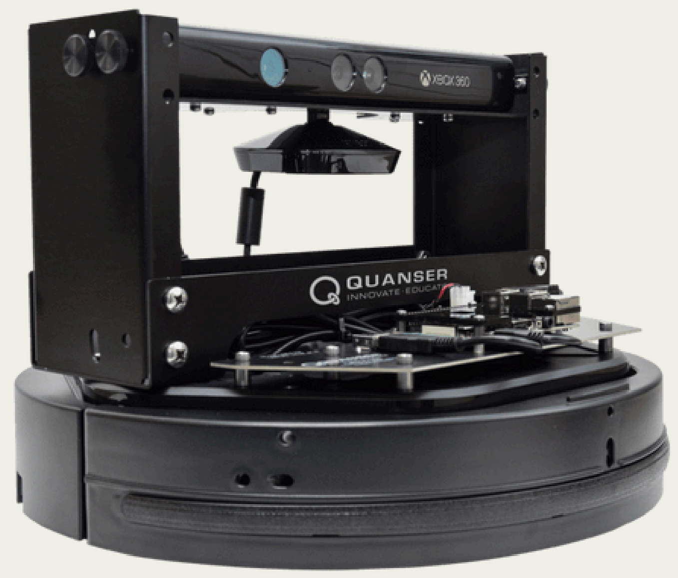
- Use of product is limited to government use

Compliance (Rules, Regulations, and Standards)

- Certification: Obtain a valid UAS certification
- Registration: Register your drone with the FAA and display the registration number on the outside

PRODUCT SPECIFICATION - QBOT

Items	Quantity
Platform	2-wheel differential drive base with 4 support castors
Diameter	570 mm
Height	227 mm
Drivetrain sensing	Current sensing, optical encoders, and digital tachometer per wheel
Nomial motion	0.7m/s speed and 0.5 m/s/s acceleration
Maximum payload @ maximum motion	20 kg
Operation time	2 hours per battery
Power	Up to 2x 84Wh LFP batteries w/ external charging



PRODUCT SPECIFICATION - QDRONE

Items	Quantity
Dimensions	50 x 50 x 15 cm
Weight(With Batteries)	~1500 g
Max Payload	~300 g
Power	4S 14.8V LiPo (3700mAh) with XT60 connector
Flight Time	7 - 8 minutes for hover per battery charge
Onboard Computer	NVIDIA Jetson Xavier NX SOM (powered by a 6-Core NVIDIA Carmel ARM v8.2 64 Bit processor)
Onboard Sensors	2x 6-DOF IMU (gyroscope and accelerometer), 1x Optical Flow sensor, 1x ToF height sensor
Connectivity	WiFi 802.11a/b/g/n/ac 867Mbps with dual antennas 1x Micro HDMI port for external monitor support
Supported Software and APIs	QUARC for Simulink, Quanser APIs, TensorFlow, TensorRT, Python 2.7 & 3, ROS 1 & 2, CUDA, cuDNN, OpenCV, Deep

SOLUTION GENERATION- DESIGN SELECTION

Idea	Pros	Cons
QUARC Real-Time Control Software for ground to air communication and control	QUARC software is integrated directly with MATLAB and Simulink, making it easy for users to develop control algorithms. Additionally this allows for real time control.	For users without extensive experience, implementing advanced features may be challenging.
PX4 Autopilot for ground to air communication and control	Allows for custom ground to air communication setups	The internal integration of PX4 can possibly make customizing source code time-consuming due to its parameters.
Use DJI software development kit for ground to air communication and control	User-friendly and allows developers to build mobile applications that can control drones	Only compatible with DJI drones

- Each member brought forward a solution for choosing a control software for our ground control station
- The QUARC Real-time Control Software and PX4 Autopilot Software were chosen as the top ideas for comparison.

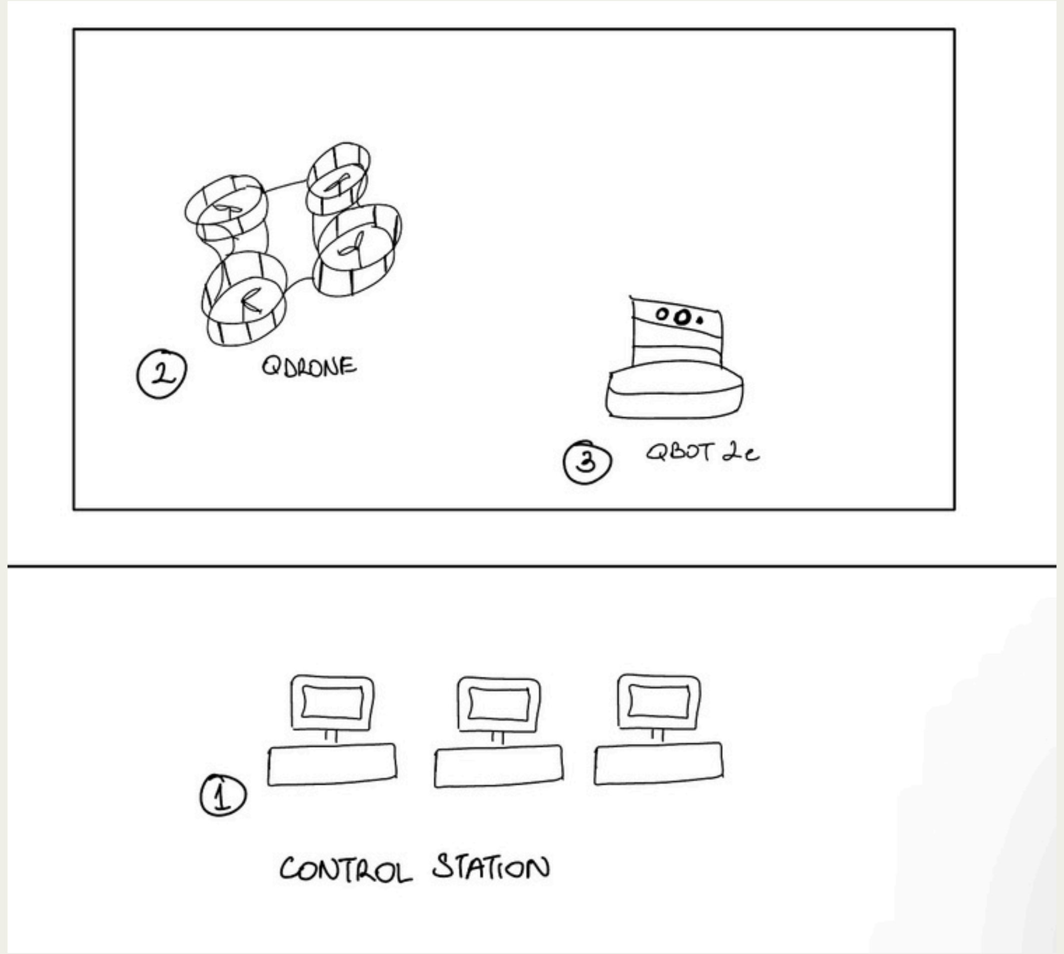
SOLUTION GENERATION- DESIGN SELECTION

		QUARC Real Time Software		PX4 Autopilot	
Attribute	Weight	Score1 - lowest5 - highest	Agg. Score	Score1 - lowest5 - highest	Agg. Score
Compatibility	0.3	5	1.5	2	0.6
Cost	0.2	3	0.6	5	1
Performance	0.5	4	2	3	1.5
TOTAL			4.1		3.1

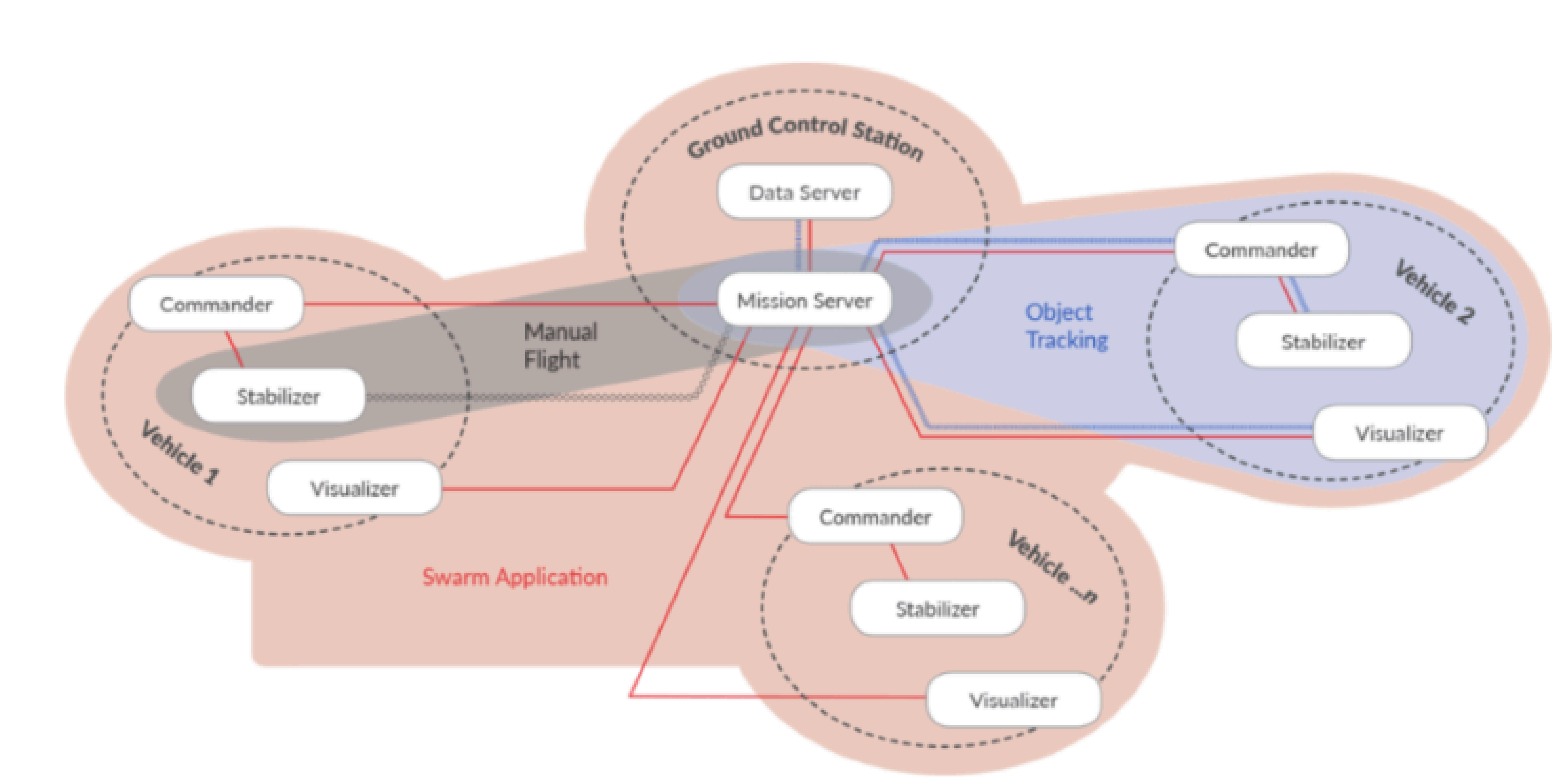
- The performance matrix was based on performance, compatibility with hardware, and cost, with performance carrying the highest weight.
- The QUARC Real-Time Control Software, with the highest score was selected as control software for the Ground Control Station.

DESIGN DESCRIPTION

- QDrone (2) and Qbot(3) are set up in an enclosed space, and are wirelessly connected to Ground control station (1).
- Control algorithms are uploaded using the QUARC Real-time Control software and then deployed to the Qbot and Qdrone. The data gathered by the Qbot and Qdrone are sent to the QUARC software and monitored by the control station in real-time.



COMPONENENT-LEVEL SCHEMATICS



Parts	Quantity
Qdrone	6
Qbot 2	6
Ground Station	1

- The above diagram shows a component level blueprint of the Ground Control Station, Ground vehicles (Qbot2) and aerial vehicles (QDrone). It shows how multiple vehicles will be set up and connected to the ground control station.

CONCLUSION

- Our project involves the use of an autonomous vehicle system. Such a system can be used in several modern applications especially disaster relief. To select the right combination of hardware and software, we compared different components and selected the final design for the project. The autonomous vehicle system used in this project will have communication between a ground control station, ground vehicle (QBot2) and an aerial vehicle(Qdrone). The ground vehicle will act as the leader, and aerial vehicle as the follower.

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Thank you