UAS EQUIPMENT CONSIDERATIONS

CRITICAL COMPONENTS FOR A SAFE & SECURE SYSTEM

EXECUTIVE SUMMARY

- There have been many new Advances In UAS(Unmanned aircraft Systems)
- Key factors prices, combat systems, types, attachment, and prices
- Cyber security
- Control

OPERATING AND CONTROL SYSTEMS

- Drone are made up of two primary operating systems:
  - Movement System
  - Control System
    - yaw, pitch, roll and throttle
- Ground control systems

UAS EQUIPMENT CONSIDERATIONS

- Payload for UAS consists of sensory packages, audio packages, cameras, power, weight, and fuel.
- A major key factor while in flight, is the need to have a system to combat information being compromised. UAS's all have payload requirements which will depend on what mission that drone and system can accomplish.
- The control center of a UAS consists of a user interface, radio transmitter and modem, antenna, handheld control, recovery and launch equipment.
- Factors of UAS systems that all companies feel the need to have is a system that will automatically return the drone back to where it came from when the power level gets below a desired point.

TYPES OF DRONES

Type of Drone	Pros	Cons
 Multirotor	• Easy to manufacture • Inexpensive • Easy to operate and can take-off and land in most locations • Smaller crash potential	• Short battery life (15-25 minutes max for most models) • Limited endurance and speed • Smaller payload capacity
 Fixed Wing	• Can be in the air for many hours at a time • Fast flight speed • Fuel efficient	• More expensive • Launch and landing requires a large area • More difficult to fly • Needs to constantly stay in motion • Pilots need special training

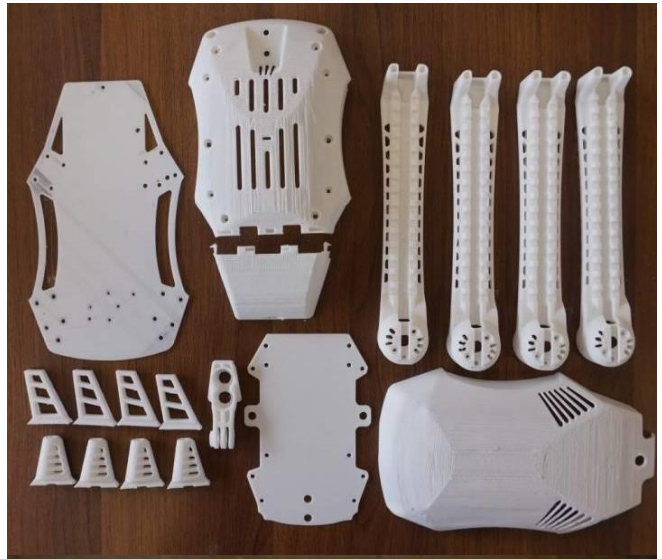
- Quadcopter drones are the most used type of drone, as they are easy to operate and can be launched and retrieved from almost anywhere
- Fixed Wing drones are harder to fly and are better suited for long distance flights

DRONE ATTACHMENTS

- Drone attachments allow users to modify their drones and make changes that are most suited for their mission
- Some of the most popular drone attachments are:
  - Different Cameras or Sensors
  - Additional Batteries or Charging Systems
  - Stabilizers
  - Protection Attachments

DRONE ATTACHMENTS – 3D PRINTING

- 3D printing UAS parts is quick and low-cost way to produce parts for your drone
- Replacing broken parts, producing protection pieces, and creating custom printed designs for equipment are all advantages of using 3D printing to modify your drone
- Many free resources are available online to find pre-existing designs and models for a user to download and print out themselves (GrabCAD, Thingiverse, Iflight)
- 3D printing is becoming more accessible to a larger audience, and **the future of drone technology and 3D printing will go hand in hand as technology continues to improve**



COST CONSIDERATIONS

One-Time Costs *(One time)*	• Initial fleet of Unmanned Aerial Systems (UAS)
	  • UAS trainer bundles
	  • Extra batteries/SD cards, etc.
	  • Advanced payloads, etc.

Recurring Costs *(Continuous)*	• Inventory management
	• Repairs/replacements, etc.
	• Software for analytics
	• Employee Part 107 training (initial and recurring)
	• Employee Part 107 Airmen Knowledge Tests (AKTs)
	  • Unmanned Aircraft General (small) (UAG)
	  • Recurrent test name and code

Costs of Expansion	• New equipment • More data storage/systems • Advancements in data analytics software/payloads
Unexpected Costs	• Stolen equipment • Fines, legal fees, liabilities etc.

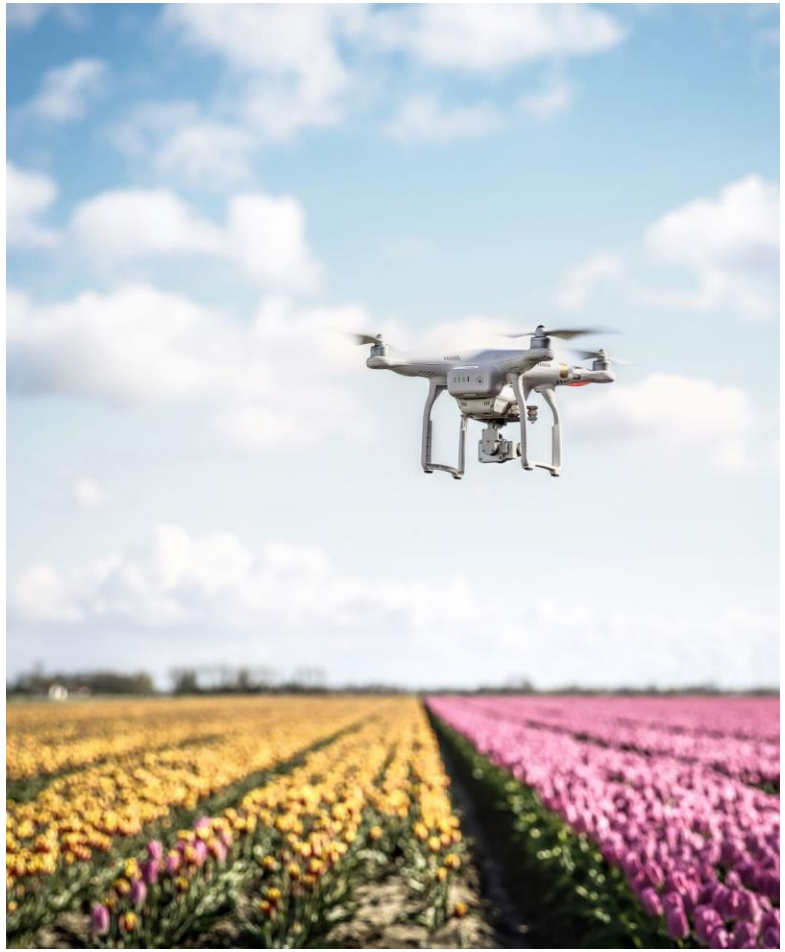
Tellevate, K.T. (n.d.). Home. Retrieved April 15, 2021, from https://kestrelmanagement.com/drones-101-uas-program-management/

- Cost considerations are a vital part of UAS because it allows for the use of unmanned aircraft systems to operate and complete tasks in various fields and industries, efficiently and effectively
- UAS cost considerations involve prices that are dependent on various aspects of UAS Operation
- While drones are unmanned, their operation still requires many physical components to carry out different tasks
- The necessary training goes beyond piloting and flight
- Range of costs to be considered are based on different aspects of UAS utilization.

DRONE PRICES

There are many factors involved in deciding what drone to choose

- Price of a drone compared to traditional aviation
- Acessories/Equipment that comes with the drone
- 5 Drones approved to be bought with Government Funding: Skydio's X2-D, Parrot's Anafi USA, Altavian's M440 Ion, Teal Drones' Golden Eagle, and Vantage Robotics' Vesper. (All produced in the United States)
- Highly used drones in the United States

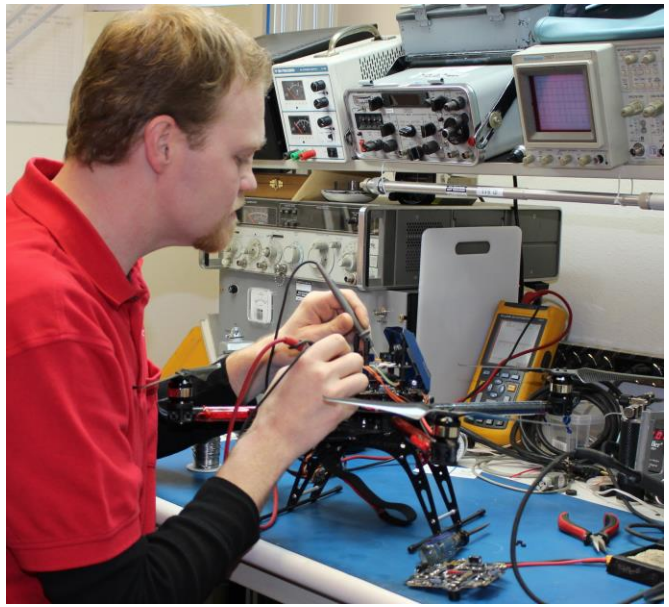


DRONE PRICES EXAMPLES

Drone Type	Specs	Price
Skydio X2 (Made in the U.S.)	• Camera: 4k, 16fps (frames per second) • 35-minute battery life • Good for: Search & Public Safety Inspections • Range: up to 6 miles • Operations: Day or Night	Ranges from $10,000 to $20,000
Skydio 2 (Made in the U.S.)	• Camera: 12-megapixel stills, 4k HDR Video • 23-minute battery life • Good for: Construction, Filmmaking, & Marketing	Pro Kit: $2,499
Parrot Anafi USA (Made in the U.S.)	• Camera: 4k • 32-minute battery life • Good for: Search & Emergency	Ranges from $14,000 to $16,000
DJI FPV Combo (Made in China)	• Camera: 4k • 20-minute battery life • Range: up to 6 miles without obstruction	$1,299

MAINTENANCE AND UPGRADABILITY

- **Maintenance is classified as any action preformed on the ground before or after flight to ensure the successful and safe operation of the system.**
  - Most small UAS operations are without a dedicated maintenance personnel.
- **Maintenance Categories:**
  - Scheduled
  - Unscheduled
    - Less predictable than Scheduled Maintenance
- **Maintenance costs add up: an estimated 50% of direct operational cost will come from maintenance**
- **Drone upgradability:**
  - Some drones are manufactured to have swappable or upgradable parts. (Mission Dependent)
  - Software as a commonly overlooked cost consideration



TRAINING

What is the cost?

- Part 107 Certification
  - Multiple choice Exam
  - 24 months
- Lessons

What will training consist of?

- Proper Rules and Regulations
- Airspace Classification
- Flight Restrictions
- Limitations
- Effects of weather
- Radio communication
- Operation of UAS

What makes a certified pilot?

- Passing Part 107
- FAA Tracking Number (FTN)

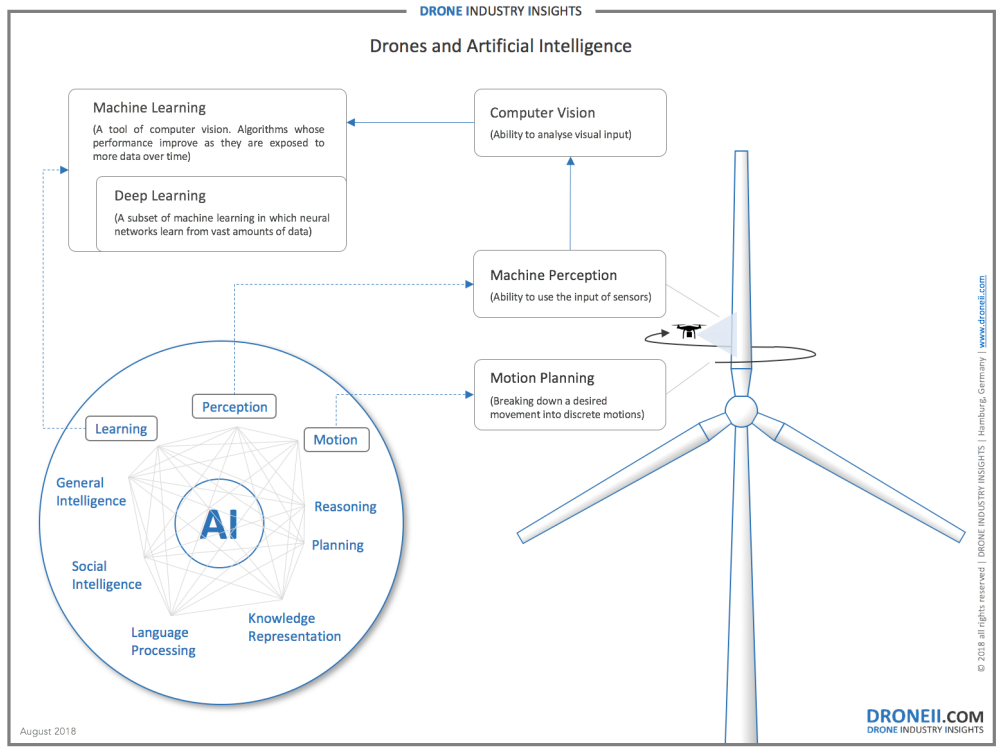
DRONE SAFETY

- Drone safety is essential to prevent any problems that can occur while operating a drone
- System reliability and mission reliability are critical
- What prevents the drones from working properly?
  - Weather; wind, precipitation, etc.
  - Lack of Training/On-going Training
  - Maintenance

DRONE SAFETY CONTINUED

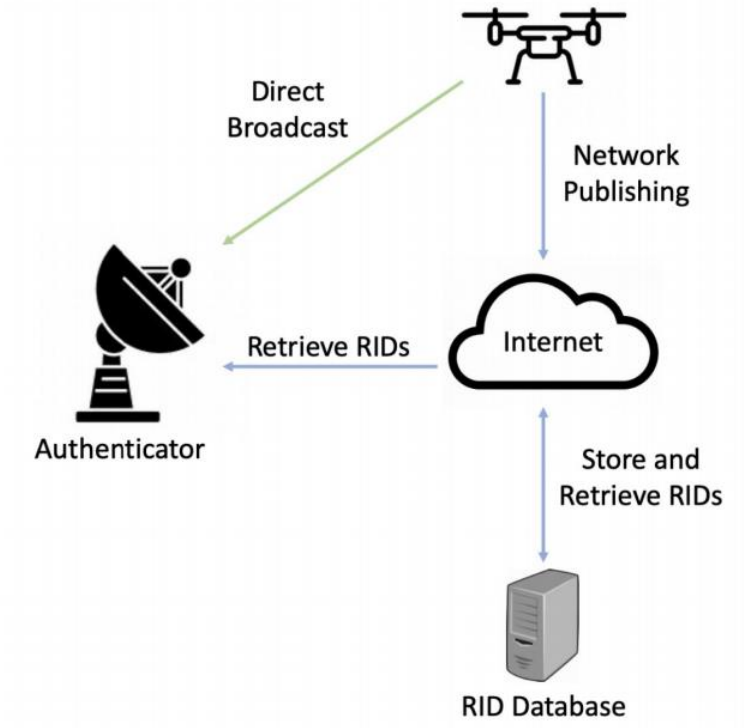
- Safety systems set the pace for future innovations
  - Safety protocols will play a role on whether an organization will purchase a drone
- Who is affected by drone safety?
  - People
  - Critical Infrastructures
- Part Consideration
  - Blade coverage
  - Weight restrictions

ARTIFICIAL INTELLIGENCE



- Managing the data
- Components of drones are:
  - Computer vision
  - Sensors
- Include various sectors

CYBERSECURITY

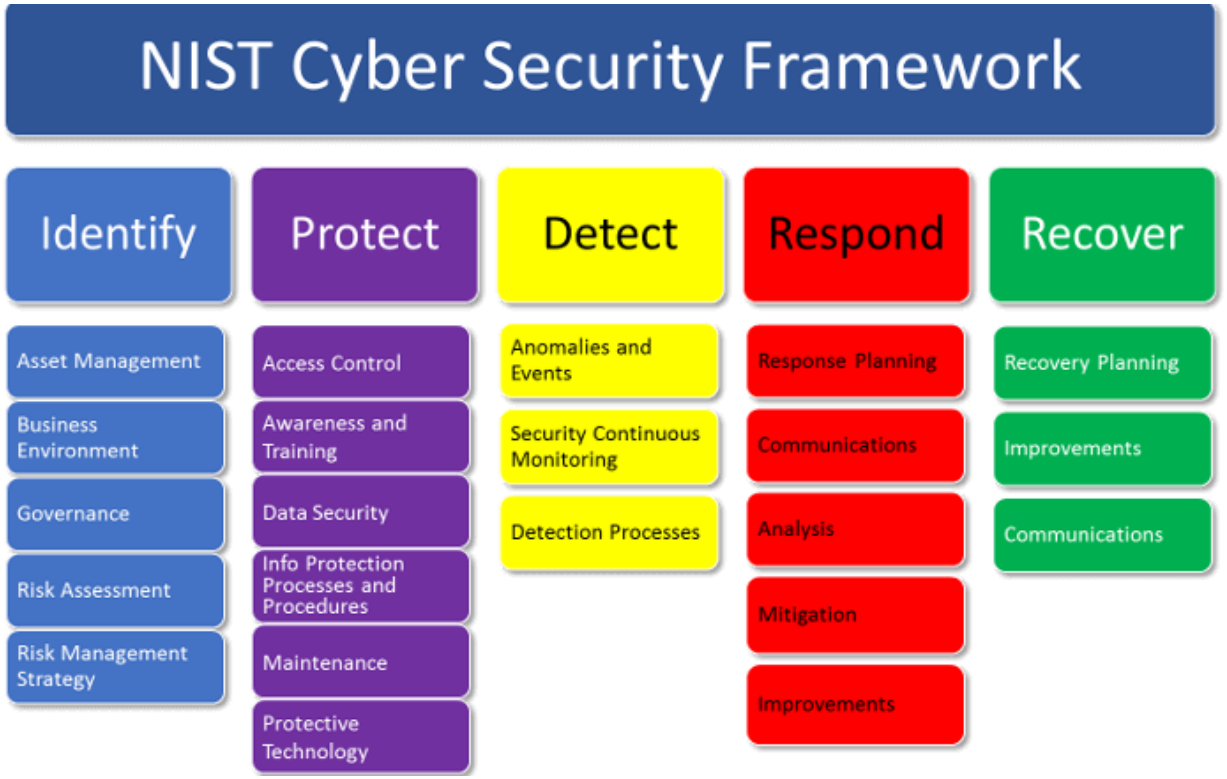


- Testing by the United States Government
- Authentication
- Biometric authentication
- Remote user authentication
- Encryption
- Network security

CYBERATTACK DETECTION AND RESPONSE

- Even with precautions in place to handle intrusion, vulnerabilities will always be present.
- Malware such as keystroke monitoring systems present serious problems since they are difficult to detect with most antivirus systems.
- Antivirus software continues to be a valuable tool, but artificial intelligence techniques may soon be able to detect cyberattacks instantaneously.

CYBERATTACK RESPONSE AND DETECTION



Source: https://www.givainc.com/blog/index.cfm/2019/7/24/5-Key-Changes-Made-to-the-NIST-Cybersecurity-Framework-V11

- Organizations must have a framework in place in the event an intrusion does occur, and who responds will be dependent on the organization.
- Cyber risk tolerance is the amount of risk an organization is willing to accept, built into the organization's framework.

CYBERATTACK RESPONSE AND DETECTION

CONCLUSION

UAS equipment considerations is a broad and general topic

Cost considerations include initial drone price, maintenance and training

When designing a UAS program safety must be a top priority

The future of drones is in Artificial intelligence

With a bigger emphasis on software, cybersecurity is a must for any UAS program