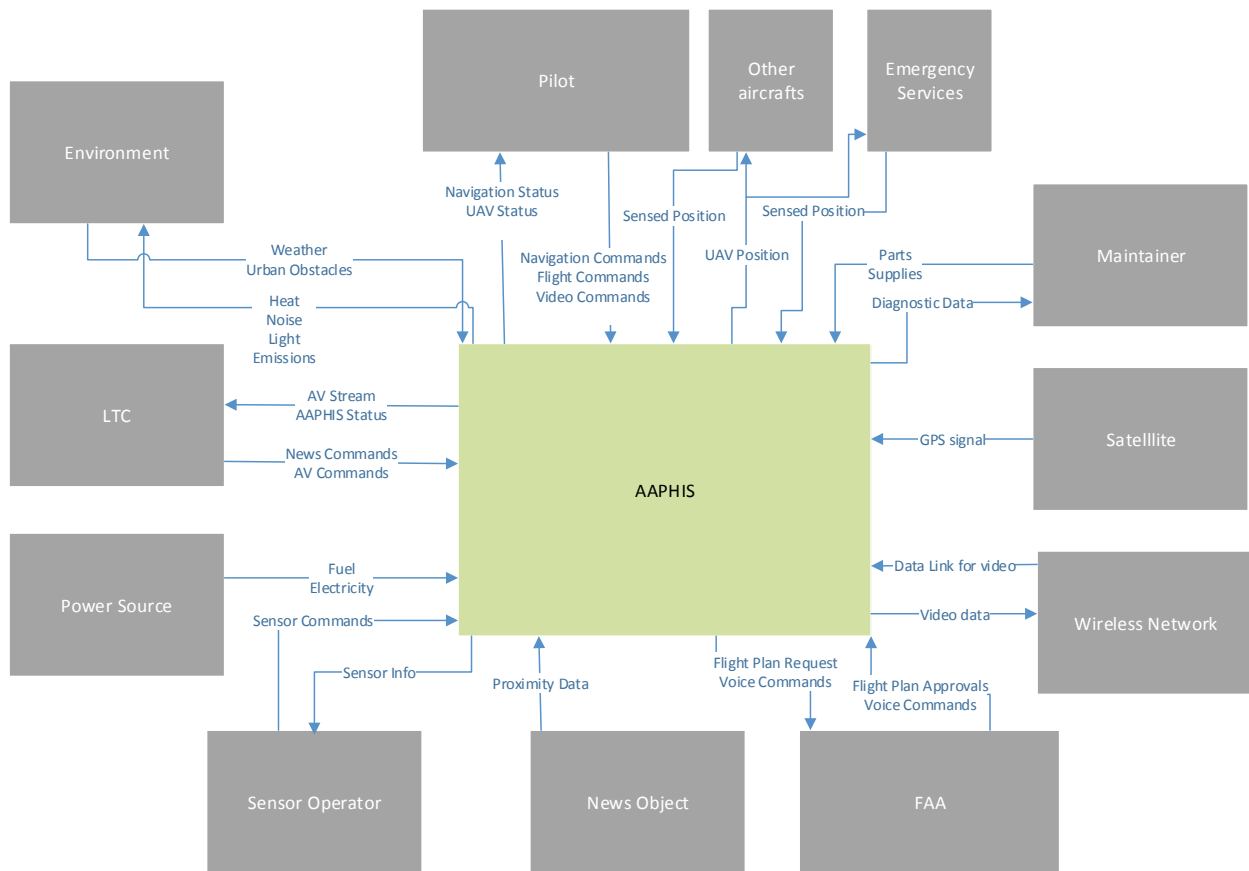


**a. Context Diagram**

- i. An overall description with objectives**
- ii. The typical environment**
- iii. Manmade and natural threats**
- iv. Other entities that will or may interact with the system**

Systems Context Diagram



**Scenarios**

Three scenarios will be outlined to identify plausible solutions for the AAPHIS system to react to emerging news events autonomously.

- 1. Reacting to emerging events and Capturing Video- Standard Operation

2. Sense and Avoid

3. Lost Link

The scenarios will assist in the development of the Autonomous Airborne Photography Imaging System by providing an operational context for the new system over the next 5 years. The scenarios will be used to identify how the system will react in a standard operational environment.

### **Scenario 1: Reacting to emerging events and Capturing Video**

#### **Description**

The purpose of this scenario is to identify plausible solutions for the AAPHIS system to react to emerging news events capture and stream video autonomously.

#### **Mission Description**

The mission is to accept news event coverage request from LTC headquarters and capture video of the news event autonomously until coverage is no longer needed or maintenance is required. The mission objectives are to successfully deploy an unmanned aerial vehicle (UAV), and autonomously and safely navigate to a news event, track the event and report the event back to LTC.

#### **Objectives**

Launch Air Vehicle from LTC facilities in response to mission tasking notification from LTC Newsroom.

Navigate to news event autonomously.

Record and transmit the news event to LTC.

Navigate back to LTC facilities.

Recover Air Vehicle safely at LTC facilities.

Make UAV ready for the next mission.

#### **Success Criteria**

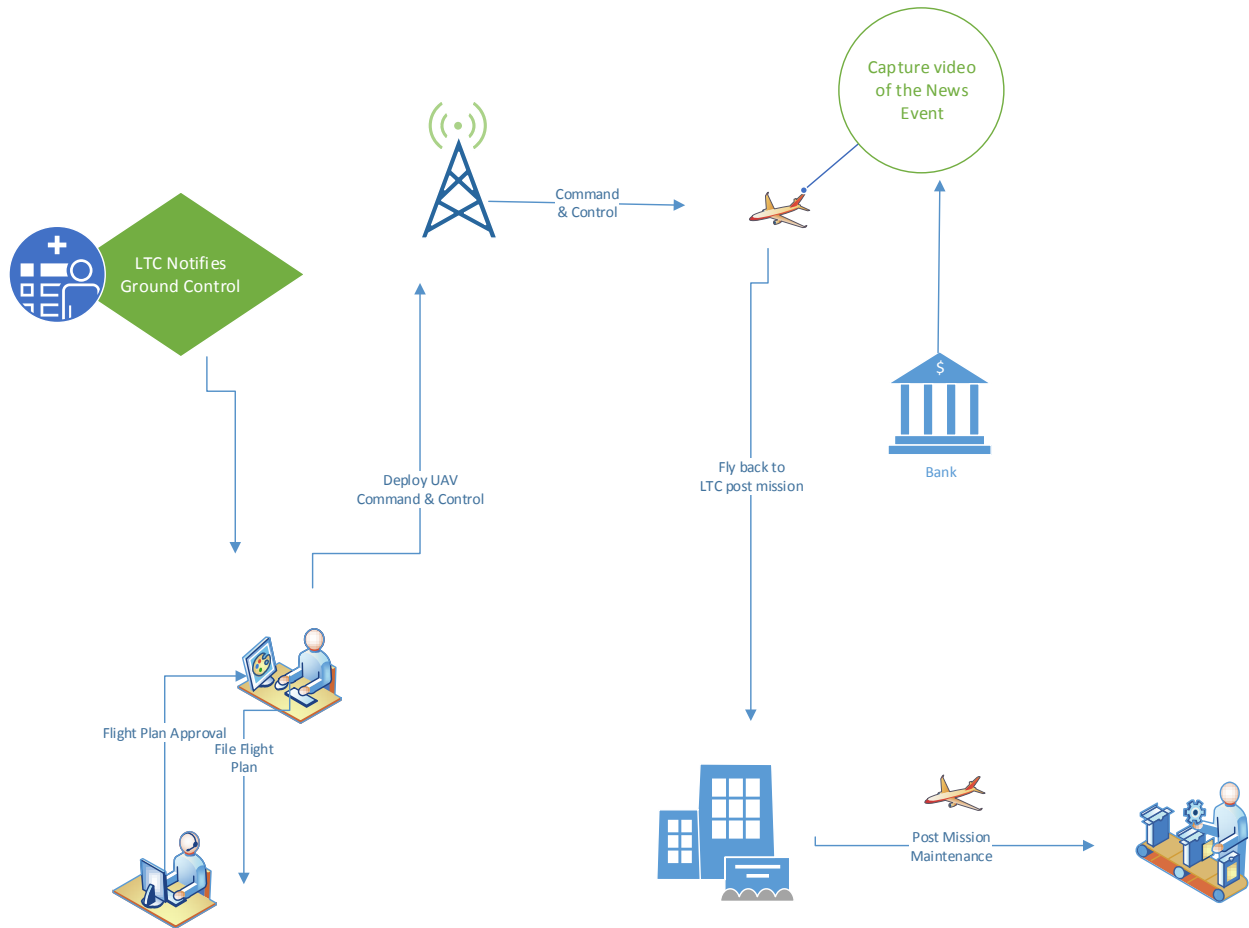
UAV Operator(s) at duty stations within 5 minutes of mission tasking notification.

Air Vehicle is airborne within 1 hour of mission tasking from Newsroom.

Air Vehicle is over the news event within one hour of launch.

Air Vehicle is recovered without damage to itself or other property.

Maintenance personnel complete turnaround maintenance within one hour of recovery.



## Operational Environment

7 AM Sunday a bank is robbed in downtown Baltimore and civilians are taken hostage by the robber. The police have surrounded the bank and negotiators are on the way. LTC headquarters alerts ground control to the breaking news event and requests coverage for the duration of the event. Ground control uploads mission plan and deploys the UAV at 7:30 AM. The UAV reaches the destination at 8AM, identifies bank, records audio and video, and initiates loitering pattern. 15 minutes later the suspect leaves the hostages and escapes police blockade by motorcycle. Several news organizations have arrived at the scene with aircraft, and the police are in pursuit. Ground control takes manual control of the UAV and identifies object to follow until suspect is detained. After the suspect is apprehended or fuel levels are low the UAV returns to the station.

## Timeline of Events:

**Time T** Newsroom notifies AAPHIS Ground Control Station that AAPHIS coverage is required for coverage of a news event.

**Time T** GCS notifies Support personnel to ready UAV for launch. GCS notifies UAV operator(s) if not already in GCS.

**T+00:05** Operator(s) arrive in GCS.

**T+00:10** Operator checks weather, provides mission plan to FAA and commences pre-flight checks.

**T+00:30** UAV is launched under direct control of the operator.

**T+00:31** once clear of LTC property, UAV flies autonomously to the news event.

**T+01:00** UAV reaches news event. Operator de-conflicts with one police and one other news aircraft in the area; notifies ATC as necessary of intentions.

**T+01:00** Sensor operator switches on sensor package and designates object to cover

**T+01:00** video begins secure streaming to GCS and is recorded on board. Video is stored in GCS and provided in real time to LTC newsroom.

**T+02:00** under control of the UAV sensor operator, with input from LTC newsroom, sensor package is switched off.

**T+02:00** UAV returns autonomously to LTC facilities.

**T+02:30** once arriving at LTC property, UAV Operator takes over direct control of UAV and recovers UAV safely.

**T+02:30** GCS placed in standby mode. UAV operator(s) and GCS personnel close flight plan and commence post-flight debrief.

**T+02:30** Maintenance personnel begin "turnaround" maintenance.

**T+03:30** Maintenance personnel complete "turnaround" and UAV is ready for next tasking.

## **Physical Environment**

**Meteorological:** The scenario will take place in weather conditions equal to or better than FAA-defined Visual Meteorological Conditions (3 miles visibility and 1,000 ft. ceilings).

**Communications:** RF between UAV and GCS; VHF voice communications with other traffic and FAA as necessary.

## **Manmade and Natural Threats**

The threats to the system include

- Theft (Ground Stations equipment, data theft etc.)
- surface-to-air missiles
- Aircrafts (Fixed wing and rotary)
- Birds

- Lasers, jamming and radio frequency weapons
- Other conventional weapons e.g.-chemical weapons
- Sabotage to the physical ground system and aerial vehicles
- Hacking and unauthorized control of the UAV's
- Weather events

### **Competition**

- Google drones
- Amazon drones
- Twitter/Periscope live streaming can make overhead news reporting redundant
- Other private unauthorized drone operators

### **The scenario will assume the presence of other systems as:**

**LTC Newsroom:** Initial notification and modification of mission tasking, communication and transmission of live streaming video.

**FAA ATC:** communication (VHF), notification of air traffic, filing flight plans

**GPS systems:** Provide navigational data to the system

### **Scenario 2: Sense and Avoid**

#### **Description**

The purpose of this scenario is to identify plausible solutions for the AAPHIS system to detect and react to any airborne objects that may or may not have collision avoidance systems.

#### **Mission Description**

The mission is to detect airborne objects and determine if a potential collision hazard exists. In case of a hazard the system shall notify the operator of the hazard and provide a course of action for the UAV operator or autonomously maneuver to avoid the other object.

#### **Objectives**

System shall display warning messages to the UAV operator of collision hazards

Allow adequate time for the UAV operator to perform evasive maneuvers

Able to autonomously take evasive actions

Provide override capability to the UAV operator

## Success Criteria

The system displays all airborne threats to the UAV operator

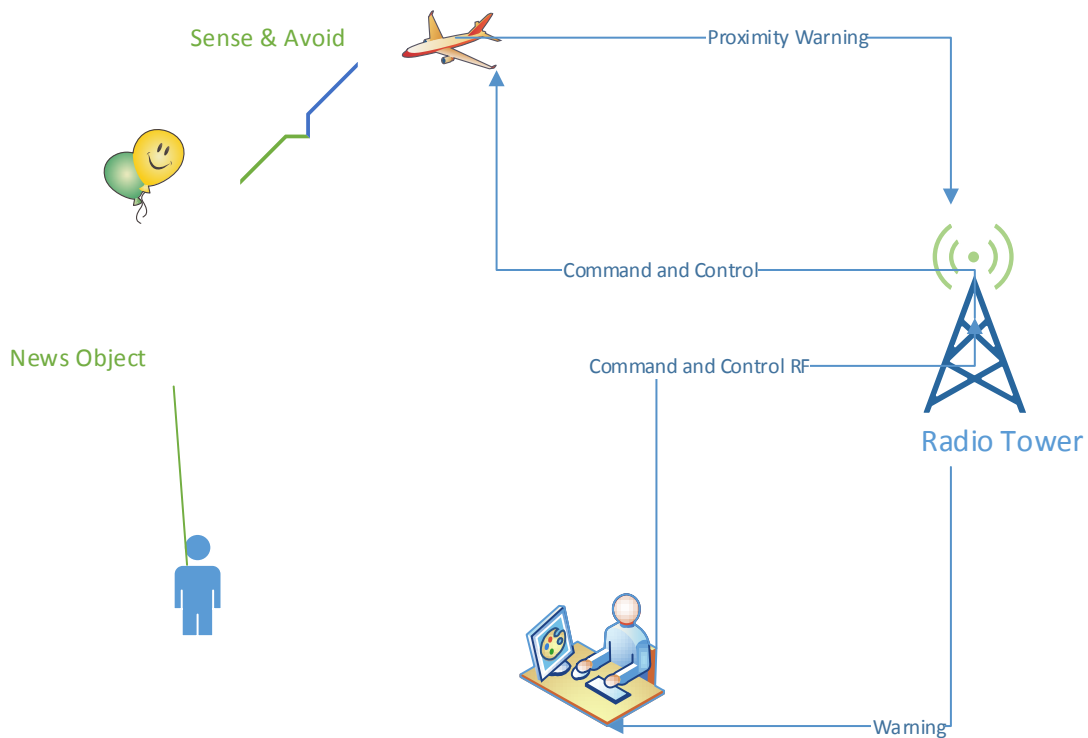
Air Vehicle does not interfere with the news event (including emergency responders if applicable).

UAV Operator(s) at duty stations will have adequate time to maneuver the UAV to avoid collision by 1000 ft.

The UAV does not get collision avoidance inputs within 500 ft. it will perform an autonomous evasive maneuver

The UAV will have an override capability for autonomous maneuvers

The sense and avoid system functions under emergencies like engine failure



## Operational Environment

11 AM Sunday a civilian has been taken hostage by a thug at a fair ground. Public in the fairground is in a state of panic. LTC headquarters alerts ground control to the breaking news event and requests coverage for the duration of the event. Ground control uploads mission plan and deploys the UAV at 11:30 AM. The UAV reaches the destination at 12PM, starts to records audio and video, and initiates loitering pattern. Several news organizations have arrived at the scene with helicopters and there are several helium balloons that have escaped the grounds. The UAV displays warning messages to the operator about the impending collisions with the balloons. The UAV operator performs evasive maneuvers but comes dangerously close to a flying helicopter. At this stage the UAV engages the auto evasive maneuver and steers clear of the flying helicopter and also out of the way of randomly flying balloons. Once the hazards are at a safe distance the Operator goes back to a loiter pattern and continues to record video. Once the hostage is apprehended, the UAV returns to the station.

#### **Timeline of Events:**

**Time T** Newsroom notifies AAPHIS Ground Control Station that AAPHIS coverage is required for coverage of a news event.

**Time T** GCS notifies Support personnel to ready UAV for launch. GCS notifies UAV operator(s) if not already in GCS.

**T+00:05** Operator(s) arrive in GCS.

**T+00:10** Operator checks weather, provides mission plan to FAA and commences pre-flight checks.

**T+00:30** UAV is launched under direct control of the operator.

**T+00:31** once clear of LTC property, UAV flies autonomously to the news event.

**T+01:00** UAV reaches news event. Operator de-conflicts with one police and one other news aircraft in the area; notifies ATC as necessary of intentions.

**T+01:00** Operator switches on sensor package.

**T+01:00** video begins secure streaming to LTC and is recorded on board. Video is stored in GCS and provided in real time to LTC newsroom.

**T+01:15** UAV senses helium balloons on collision course.

**T+01:15** UAV operator notified of the hazard and recommended of an alternate course

**T+01:16** UAV operator ignores the alternate course and takes evasive actions

**T+01:16** UAV senses a helicopter within 500 ft. and disengages manual control and takes evasive action to put itself at a safe distance from both the helicopter and the balloon

**T+01:17** UAV goes back to the loitering pattern and returns the controls to the UAV operator

**T+02:00** under control of the UAV Operator, with input from LTC newsroom, sensor package is switched off.

**T+02:00** UAV returns autonomously to LTC facilities.

**T+02:30** once arriving at LTC property, UAV Operator takes over direct control of UAV and recovers UAV safely.

**T+02:30** GCS placed in standby mode. UAV operator(s) and GCS personnel close flight plan and commence post-flight debrief.

**T+02:30** Maintenance personnel begin “turnaround” maintenance.

**T+03:30** Maintenance personnel complete “turnaround” and UAV is ready for next tasking.

### **Physical Environment**

**Meteorological:** The scenario will take place in weather conditions equal to or better than FAA-defined Visual Meteorological Conditions (3 miles visibility and 1,000 ft. ceilings).

**Communications:** RF between UAV and GCS; VHF voice communications with other traffic and FAA as necessary.

### **Manmade and Natural Threats**

**Weather:** limited to VMC, threat of pop-up thunderstorms, wind conditions for launch/recovery. Weather report obtained prior to launch and updated as necessary during flight.

**Other Aircraft:** may include emergency responders, other news helicopters; required to sense/avoid VFR aircraft at all times during flight portion

**Other airborne objects:** may include surface-to-air missiles, balloons, birds, kites, fireworks

### **The scenario will assume the presence of other systems as:**

**LTC Newsroom:** Initial notification and modification of mission tasking, communication and transmission of live streaming video.

**FAA ATC:** communication (VHF), notification of air traffic, filing flight plans

**GPS systems:** Provide navigational data to the system

### **Other aircrafts with sensors**

### **Scenario 3: Lost Link**

#### **Description**

The purpose of this scenario is to identify plausible solutions for the AAPHIS system to react to loss of command and control links.

#### **Mission Description**



The mission is to re-establish link if the UAV loses its link with the ground station and in case the link is not established, the UAV shall have the capability to avoid traffic and other airborne objects autonomously and return to the station.

### Objectives

System shall display warning messages to the UAV operator on losing control and command links with the UAV

UAV shall try to re-establish connection

UAV shall auto land if link cannot be re-established

UAV shall sense and avoid autonomously when no link exists with the ground control

### Success Criteria

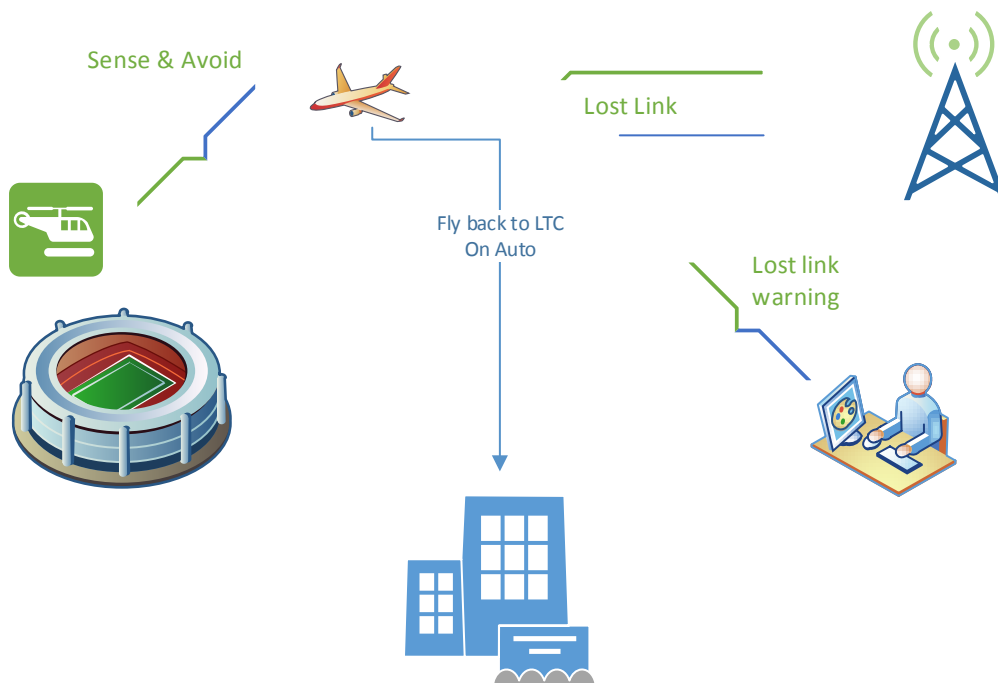
The UAV does not interfere with the news event (including emergency responders if applicable).

The UAV performs autonomous evasive maneuvers

The system notifies UAV operator on losing link with the UAV

The system notifies UAV operator on re-establishing connection

The UAV returns to base in case the link cannot be re-established



## **Operational Environment**

It is a game day and close to 50,000 fans have gathered at the stadium for the first game of the season. A commercial blimp is flying overhead. LTC requests coverage of the game. Ground control uploads mission plan and deploys the UAV. The UAV reaches the stadium and starts to record audio and video, and initiates loitering pattern. Several news organizations have arrived at the stadium with helicopters. Fans are slowly trickling into the stadium and there are tail gate parties in several parking lots and empty areas around the stadium. In the midst of filming, the link to the UAV is lost. The system displays warning messages to the operator. The UAV operator tries to re-establish connection but fails. The UAV initiates connection but fails. At this stage the blimp slowly turns towards the UAV. The UAV engages the auto evasive maneuver and steers clear of the flying blimp and having failed to establish connection, the UAV flies back on a pre-programmed route to the station.

## **Physical Environment**

**Meteorological:** The scenario will take place in weather conditions equal to or better than FAA-defined Visual Meteorological Conditions (3 miles visibility and 1,000 ft. ceilings).

**Communications:** RF between UAV and GCS; VHF voice communications with other traffic and FAA as necessary.

## **Manmade and Natural Threats**

**Weather:** limited to VMC, threat of pop-up thunderstorms, wind conditions for launch/recovery. Weather report obtained prior to launch and updated as necessary during flight.

**Other Aircraft:** may include emergency responders, other news helicopters; required to sense/avoid VFR aircraft at all times during flight portion

**Other airborne objects:** may include surface-to-air missiles, balloons, birds, kites, fireworks

## **The scenario will assume the presence of other systems as:**

**LTC Newsroom:** Initial notification and modification of mission tasking, communication and transmission of live streaming video.

**FAA ATC:** communication (VHF), notification of air traffic, filing flight plans

**GPS systems:** Provide navigational data to the system

## **Other aircrafts with sensors**