Concept Paper

Unmanned Aerial Surveillance for Perimeter Security Missions

Introduction. This paper is submitted to demonstrate a family of concepts for providing aerial surveillance in support of perimeter security operations in countries belonging to the Gulf Cooperation Council (GCC). The operational concepts discussed below are based upon the application of the capabilities provided by two systems which can be used as standalone systems or in an integrated fashion. The two systems presented are:

a. The BUSTER®, Small Tactical Unmanned Aerial System (STUAS).

b. Tethered unmanned aerial systems known as aerostats

BUSTER®. The BUSTER® family of STUAS currently consists of three different aircraft. They all utilize the same ground control station (GCS) and catapult launcher and can be recovered both by parachute and by a skid or belly landing. The standard configuration is a 13 pound air vehicle with a 49 inch wingspan. A long endurance (LE) version is also available which weighs 15 pounds with a 10+ hour endurance. These two configurations are powered by a 2-cycle gasoline engine. The third system is an electric version with a 6-foot wingspan and a 2-4+ hour endurance on batteries. All three versions are capable of carrying a 3 pound payload. BUSTER was developed by the U.S. Army and has many attributes that make it very highly desirable for operations in remote and austere conditions such as might be found in the GCC. Among them are:

- **Stability.** BUSTER's TwinWing® design has proven to be much more stable in heavy weather and high winds as might be encountered in mountainous areas. It has demonstrated survivability in 50 knot wind conditions.
- **Adaptability.** The TwinWing® design has also proven to be very flexible and adaptable. BUSTER has flown with nearly every type of sensor available

BUSTER's Ground Control Station

for its size category as was the principle test platform for the U.S. Army for developing small sensors for unmanned aerial vehicles (UAV). Therefore, the BUSTER design can be modified at the customer's request to accommodate any sensor suite or mission requirement.

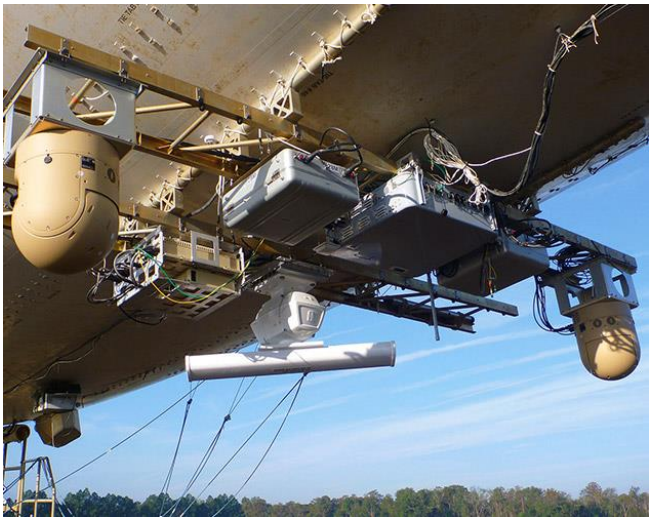
BUSTER Ready to Launch

- **Very small footprint.** BUSTER can be operated by two people and transported in a small pickup truck or sport utility vehicle (SUV).
- **Long endurance.** The "LE" version of BUSTER has approximately 2.5 times the flight endurance of any UAS in its class.
- **Maritime application.** BUSTER can be launched and recovered at sea giving it the ability to support security operations along maritime borders.
- **Operational Radius.** The line-of-sight (LOS) communications range of the BUSTER® family is 20 nm for a single aircraft. However, up to five aircraft can be linked together in order to extend this range if necessary.
- **Cost.** A typical "system" consists of four aircraft, one GCS and one launcher. Due to BUSTER's long endurance and low price point, the cost per operational flight hour is typically 20-50% of the cost of other UAS in its class.

Aerostats. The aerostat is a fixed site, tethered airborne sensor platform. Many configurations are available. The U.S. armed forces have deployed them extensively in Iraq and Afghanistan to provide perimeter security surveillance for remote bases of operation in support of coalition forces. The same systems can provide outstanding support for security surveillance of any perimeter, along borders, high value assets, etc. Depending upon the launch altitude, they are capable of carrying sensor and/or communications suites up to 400 pounds to altitudes of 3000-5000 feet above ground level (AGL) for periods of 10-14 days. As launch altitude increases, payload decreases, with the appropriate tradeoffs, operational altitudes of 10,000 feet above mean seal level (MSL) are achievable. Operational attributes that are particularly attractive to the perimeter security mission include:

- **Sensors.** With a payload capacity of 400 pounds, the aerostat is able to carry a variety of sensors that are much more capable than the typical UAV. A UAV capable of carrying

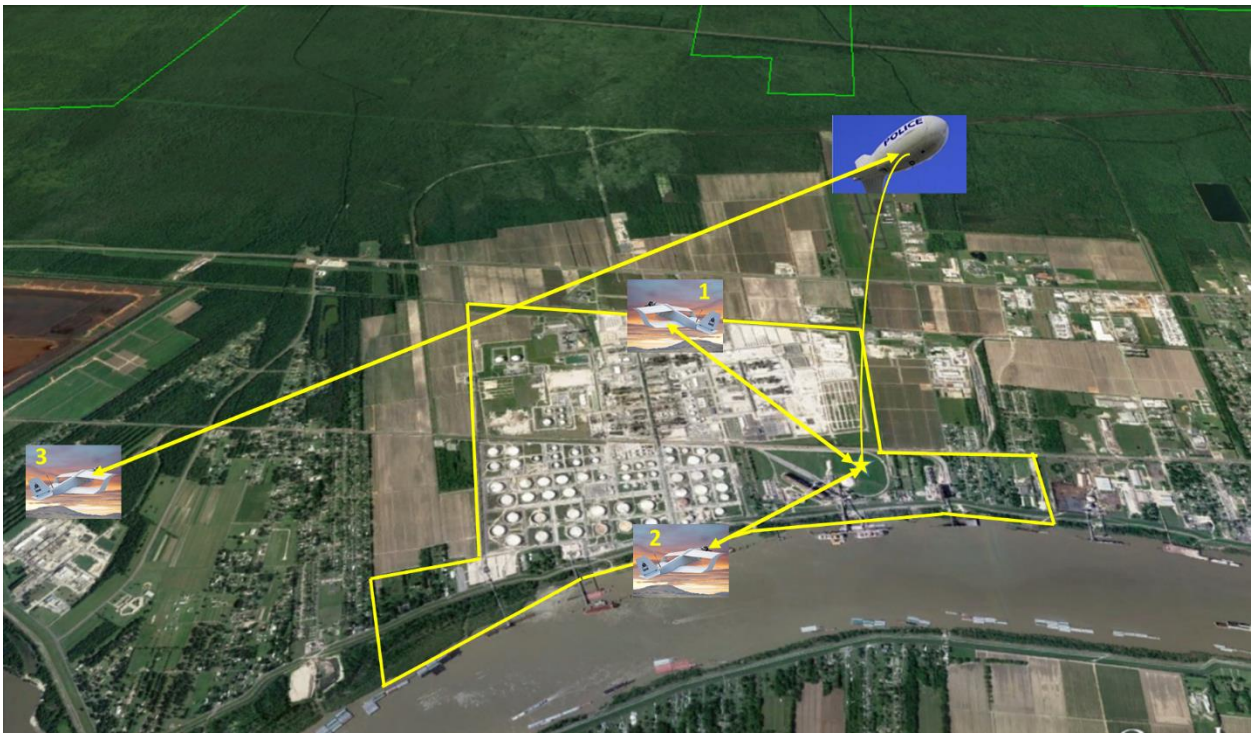
equivalent capability would be orders of magnitude more expensive to own and to operate. Depending upon selection, electro-optical (EO) and/or infrared (IR) sensors are available that can provide excellent surveillance capabilities 10-20 miles from the launch site depending upon the size of the anticipated target.



- **Communications.** The aerostat is capable of carrying the most capable communications suites to altitudes of 3000-5000 feet AGL and powering them from the ground. At the launch site, it can also network these communications suites with any other communications networks that may be available to include land lines, cellphone networks, or satellite communications. Therefore, any information collected at this site can be forwarded anywhere in the world in real time.
- **Communications relay.** Due to the ability to support this robust communications suite, the aerostat can carry a communications relay antenna to altitudes of 3000-5000 feet AGL thereby creating dramatic increases in communications and operational ranges for UAV's. LOS communications ranges stated above for BUSTER can be more than doubled and one aerostat can support multiple BUSTER operations simultaneously.

Concepts of Operations. Both of the systems described above are capable of supporting perimeter security operations as a stand-alone system. Depending upon the specific mission, each may have particular strengths to offer. However, combinations of these systems can greatly enhance operational effectiveness. The figure below illustrates one possible concept that can be successfully executed using these systems alone or in combination.

The notional concept for perimeter security shown below is for a large oil refinery. Assume the distance around the perimeter is 14 miles and the internal area is 12 square miles. The longest distance from one edge of the perimeter to another is 5 miles. The yellow star indicates the surveillance base of operations. As stated above, the BUSTER and the aerostat can operate completely independently from one another or they can be operated as fully integrated and complimentary systems. This diagram shows an integrated concept of operations.



Operational parameters for BUSTER:

- Flight speed: 35 – 80 miles per hour (mph).
- Altitude: 200-18000 ft above mean sea level (MSL).
- Camera Field of View (FOV): 3 – 45 degrees.
- Requirements for 24/7 operations: 2-3 complete BUSTER systems and 6 personnel.

Given these parameters, a single BUSTER UAS could make one lap around the perimeter of this facility in approximately 24 minutes at loiter (slow) speed. Obviously, this time could be reduced by as much as half at higher speeds. The slower speed is usually preferred in order to give the operator the maximum amount of time to examine and analyze the video as it is being produced. A single ground control station can operate up to three aircraft simultaneously, so the "look interval" between flyovers could be reduced to as little as 8 minutes with a single BUSTER system if necessary. A BUSTER could also be redirected to any point within the complex in as little as 4-8 minutes depending upon the speed selected.

The amount of area that can be surveilled on either side of the perimeter is a function of operating altitude and camera zoom angle. These functions also directly affect the resolution of the video image being produced, so there are many tradeoffs. That said, generally speaking, the lower the altitude the better the resolution. If we assume an operating altitude of 500 feet to ensure we will have no safety of flight issues with tall structures, the diameter of the circular area

that will appear in the image can vary between approximately 25 and 400 feet depending upon the zoom setting of the camera.

Operational parameters for the aerostat:

- Operating altitude: 500-5000 feet above ground level (AGL).
- Sensor range: 10-20 miles (depending upon sensor)
- Mission duration: 10-14 days
- Requirements for 24/7 operations: One complete aerostat system and 16 personnel.

Aerostats come in many shapes and sizes and can be tailored to the specific mission requirements. Generally speaking, sensor suites capable of providing very high resolution EO and IR images at the ranges suggested in this notional scenario are readily available. The advantages of the aerostat are that it can carry much more capable sensors and keep them in the air for true "persistence" for much longer durations than a UAV.

Combined operations:

When properly integrated, the BUSTER and aerostat capabilities can be combined to produce a very powerful persistent surveillance capability. Each system can fill important operational gaps for the other. For instance, despite the aerostat's much more capable sensor capability, it will suffer from "shadow zones" where tall structures and/or terrain can limit its view. BUSTER can be employed to "look behind" these shadow zones thereby eliminating hiding places. In the particular notional scenario discussed here, BUSTER operations would be limited to the electric variant due to the potential risk of flying through flammable atmospheres. This will have the effect of reducing flight endurance to 2-4 hours per sortie (depending upon the batteries chosen) and increasing operating costs as batteries are consumed. BUSTER could be simply tasked to sit on the rail in a "ready to launch" status until the aerostat operator assigned a mission. BUSTER could then be launched within seconds and be on station over the target area of interest for a "closer look" within 4-8 minutes for any target within the perimeter or near the outskirts of the perimeter. This approach would greatly reduce the operating costs for BUSTER and extend its service life. Conversely, when the aerostat is lowered for routine maintenance every 10-14 days, BUSTER can take over all of the surveillance tasks until it is redeployed producing truly "seamless" persistence.

Both systems will be limited by certain weather conditions. That said, one of the strongest operational advantages of the BUSTER UAS is its ability to operate in heavy weather. Because of its TwinWing® design it is able to perform better than any other UAS in its class in high winds. The aerostat can operate in winds up to 30-50 miles per hour depending upon the operating altitude. If both high threat conditions and heavy weather conditions exist simultaneously, an

operational decision may have to be made to continue operations and risk losing a surveillance asset. Under these conditions, as many as 40 BUSTER aircraft could be "sacrificed" before having to risk the loss of the much more expensive aerostat.

BUSTER could also be tasked with surveillance of potential staging areas outside the perimeter that are beyond the range capability of the aerostat. If a communications relay capability is installed on the aerostat, this surveillance perimeter could be extended to as much as 50 miles outside the facility's fixed perimeter. This concept is illustrated in the diagram. BUSTER # 1 and 2 are flying the fixed perimeter of the facility and are communicating directly with the ground control station located at the base of operations. BUSTER #3 is operating beyond this perimeter and is communicating with the same command and control personnel, but through a communications relay provided by the aerostat.

Operational concept and mission design will be driven to some extent by cost. Costs vary with sensor selection, but some notional comparative cost figures are shown below:

BUSTER®: One "system" is comprised of four aircraft, one GCS and one launcher. Typical cost is $450,000 per system.

Aerostat: Costs for aerostats vary both with the size of the selected aerostat and the sensor suite. A "system" typically consists of one balloon, one set of launch and recovery equipment which requires installation, a generator, and one GCS. It also requires fuel for the generator and helium as consumables. Typical cost for the aerostat platform before sensor installation is $3-5 million per system.