

## **GUIDEKEEPER FOR IMPROVING AIR TRAFFIC MANAGEMENT IN CAIRO – RIYADH – AMMAN – BEN GURION – ISTANBUL AIRPORTS**

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### **Abstract**

This paper presents a proposal submitted by the author to some Civil Aviation authorities in Middle East airports and describes a new idea of using HAP-High Altitude Platform to perform “Airport Sky Tower” operating at 20 km altitude. The purpose of such idea is to improve the ATM – Air Traffic Management in airports by increasing significantly the affordability and the sky safety through integration of the HAP performance with ground ATC- Air Traffic Control systems.

The acronym name given to such HAP is “Guidekeeper” taken from the UK “Watchkeeper” military project aiming to improve the air traffic management and surveillance scenarios in the battle field. However the “Watchkeeper” uses a Medium Altitude UAV (Unmanned Air Vehicle) while the “Guidekeeper” by definition is a HAP flying above the ceiling of the air transport civil aircraft, i.e. above 56,000 ft altitude.

As explained in the paper there are several options to use different HAPs in development, but it looks to the author that for the Guidekeeper the best option is the Lockheed Martin HAA - High Altitude Airship aiming to achieve a flight endurance of 1 month, although the other options presented in the paper are not excluded. Lockheed Martin agreed to participate in this proposal. Presently the proposal has been submitted to CIVIL AVIATION in the USA DOT for evaluating the feasibility of the presented idea in this paper.



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## 1. INTRODUCTION

GUIDEKEEPER aims at providing Middle East with methodology and tools for new approach to detect, guide and control the flight vehicle with total automation including: (i) a long endurance high-altitude unmanned aircraft equipped with SAR (Synthetic Aperture Radar), MTI (Moving Target Indicator) and surveillance radar to detect, to track, and to guide and control a “pilot-free” aircraft flight along predicted trajectory, high rate data link transmitter and 28-35 GHz relay for deploying telecom backhaul in the sky in case of emergency; (ii) airport/ground command center system for controlling landing/taking off a “pilot-free” aircraft flight; (iii) integration with an existing ground ATC-Air Traffic Control systems and airport gathering information centers; and (iv) ground station where information is collected from the GUIDEKEEPER, processed, fused and distributed for ATM - Air Traffic Management contexts. For each airport five operation modes will be analyzed in depth in order to produce adequate and cost effective processing tools, including raw data calibration and critical objects (incoming/outgoing aircraft, moving vehicles, suspicious objects requiring emergent alarm, etc.) detection, recognition/characterization by using modern signal/pattern recognition and fusion methods: a) Air-to-Air Detection and Tracking of Aircraft; b) Air-to Air Guidance and Control of “pilot-free” aircraft flight; c) Air-to-Air Commands to Land a “pilot-free” aircraft flight; d) Improving ATM-Air Traffic Management by GUIDEKEEPER; and e) Airport-GUIDEKEEPER Flight Management Task Sharing. The processing tools developed in the project will be prospectively integrated in an ATM and ATC systems. The advantages of this new methodology will be demonstrated by means of air-to-air tests for the first, second and third modes of operation, and by air-to-field-to-air tests for the 2 other modes of operation. For each airport preliminary flight tests will be provided in order to determine specific algorithms and “finger print” requirements for developing the final GUIDEKEEPER system to improve the ATM in the specific flight tested airport.

In a similar European proposed project two feasibility flight tests will be conducted in two airports: one in the border of Germany and Belgium and the second one in Italy. The present proposal suggests to perform five feasibility flight tests in CAIRO-RIYADH-AMMAN-BEN GURION-ISTANBUL airports, in each 2 flight tests will be provided similarly to tests suggested in Belgium and in Italy. The required budget for the feasibility flight tests in CAIRO-RIYADH-AMMAN-BEN GURION-ISTANBUL airports is \$20 Million. Thereafter an operational GUDEKEEPER system might be deployed in each airport based on specifications to be determined in the flight tests. The required budget for deploying an operational system is estimated to be \$500 Million for each airport.

## 2. GUIDEKEEPER PLATFORMS

**HERON HALE UAV**



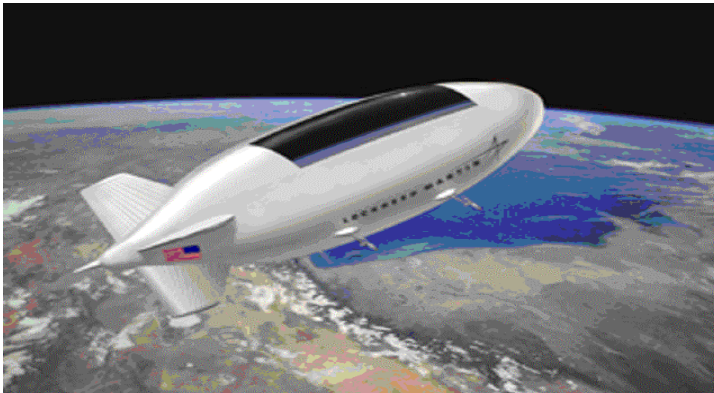
**GLOBAL HAWK HALE UAV**



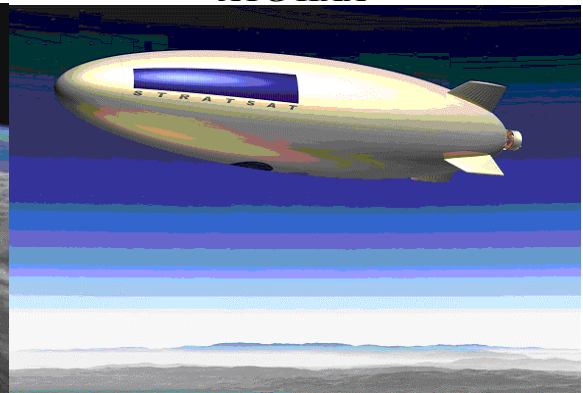
**Global Observer HALE UAV**



**Lockheed-Martin HAA**



**ATG HAA**



In the pictures described above there are presented five possible GUIDEKEEPER platforms to be deployed for operational service. The choice of the operational GUIDEKEEPER platform will be decided upon during the feasibility flight test in each airport.

Following are presented the main performance specifications of the platforms:

**Lockheed-Martin High Altitude Airship**

20 km altitude; 150 kg payload; 1 month endurance. Lockheed Martin is currently in the contract's third phase, prototype build and flight demonstration, awarded by the USA MDA.

**Advanced Technology Group High Altitude Airship**

20 km altitude; long endurance; 400 kg payload. Not announced when development is completed.

**AV Global Observer High Altitude Unmanned Air Vehicle**

20 km altitude; 1 week endurance; 200 kg payload. AV-AeroVironment received a contract from the USA Special Operations Command to develop and demonstrate 3 Global Observer aircraft.

**IAI Heron High Altitude Unmanned Air Vehicle**

Existing version Eagle I: 25,000 ft altitude; 30 h flight endurance; 250 kg payload. New Version Eagle II in development: 45,000 ft altitude; 24 h endurance; 450 kg payload

**Northrop Grumman Global Hawk High Altitude Unmanned Air Vehicle**

Existing High-Altitude Endurance Unmanned Air Vehicle was tested in USA-Australia, Europe with flight endurance of 12 h; 60,000 ft altitude; GPS navigated. New version in development will achieve 30 h endurance with 450 kg payload.

### 3. THE GUIDEKEEPER CONCEPT

Following are presented schematic description and explanation of the GUIDEKEEPER concept and role in Air Traffic Control and aircraft Guidance and Control. Future air traffic surveillance and control will be based on ADS-B system – Automatic Dependent Surveillance – Broadcast, system by which airplanes constantly broadcast their current position and altitudes, airspeed, category of aircraft, identification and whether the aircraft is turning, climbing or descending



over a dedicated radio data link. Assuming every aircraft will be fitted with ADS-B transmission, and all this information is fed to ATC centres, then a virtual radar surveillance network will be created. The system will be used for air traffic surveillance and separation by ATC centres, enhancing pilot situational awareness and supplementing Airborne Collision Avoidance System (ACAS), as well as improving ground situational awareness. ADS-B equipped aircraft will also have the capability to receive cockpit display of proximate traffic reports from other aircraft with ADS-B and ground based facilities, to obtain Traffic Information Services from ATC centre and other Flight Information Services such as weather data. It is likely that this system will be an attractive alternative to the existing surveillance radars in current ATC centres when they reach their end of economic life, providing even better air service than today.

ADS-B aircraft equipped with receiving equipment and cockpit displays will be able to be guided by ATC centre by receiving command data which will be displayed in the cockpit in lieu of radio communication. The system can be mechanized in such a way that the ATC will get a signal back when the command is acknowledged by the pilot. A GUIDEKEEPER HAP can be integrated in the future Air Traffic Surveillance system providing the following advantages:

- Flexible deployment in remote areas and harsh terrain were it is expensive to build ground ADS-B stations.
- The capability to detect and track non-cooperative aircraft beyond ATC radar range.
- The capability to receive ADS-B transmissions from and track low altitude flying aircraft by the fact that it is positioned at high altitude. This is specially beneficial in enhancing air traffic security and law enforcement, and providing better immigration and drugs traffic control.

**System Concept**

The GUIDEKEEPER concept is depicted in the following chart:

The HAP, serving as an airborne extension of the ATC ground station, will be equipped with a Radar capable of detecting air moving targets, Mode S interrogator and voice communication relay. The HAP will be controlled by the GCU (Ground Control Station) via its dedicated data link. Radar information as well as Mode S interrogation data will be sent to ATC centre via the HAP down link or via Satellite communication, depending on the relative location of the HAP and ATC centre. The information will be integrated and displayed in the ground tower as if it is originated by the ground radar.

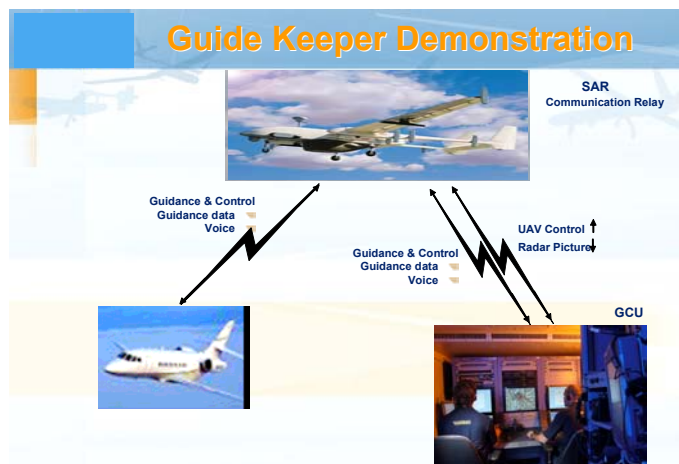


It will be possible to conduct voice communication between the tower and the controlled aircraft for guidance and control via a HAP at distances beyond the tower communication range.

The tower will be able to control and guide aircraft which are under the control of the HAP by sending and receiving data via the HAP using the ADS-B link. The control and guidance data sent by the ATC controller will be shown on the aircraft cockpit display. This mode can replace voice command in a much safer and shorter way.

**GUIDEKEEPER concept demonstration**

The demonstration system is illustrated in the following chart:



HERON UAV will be used as a demonstrator of a high altitude long endurance UAV. Such future HAP or UAV will be able to fly at altitude of 20 KM and above for a very long period of time using advanced energy sources for power.

The HERON UAV will carry air to air radar, an ATC interrogator and relay for communication system.

General Aviation Airplane (like DLR/ ATTAS airplane) will participate in a demonstration. Dedicated display will be



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installed in the airplane on which guidance and control data can be displayed. The airplane will have an ATC transponder.

The GCS will include a control station simulating the display in front a controller in an ATC centre.

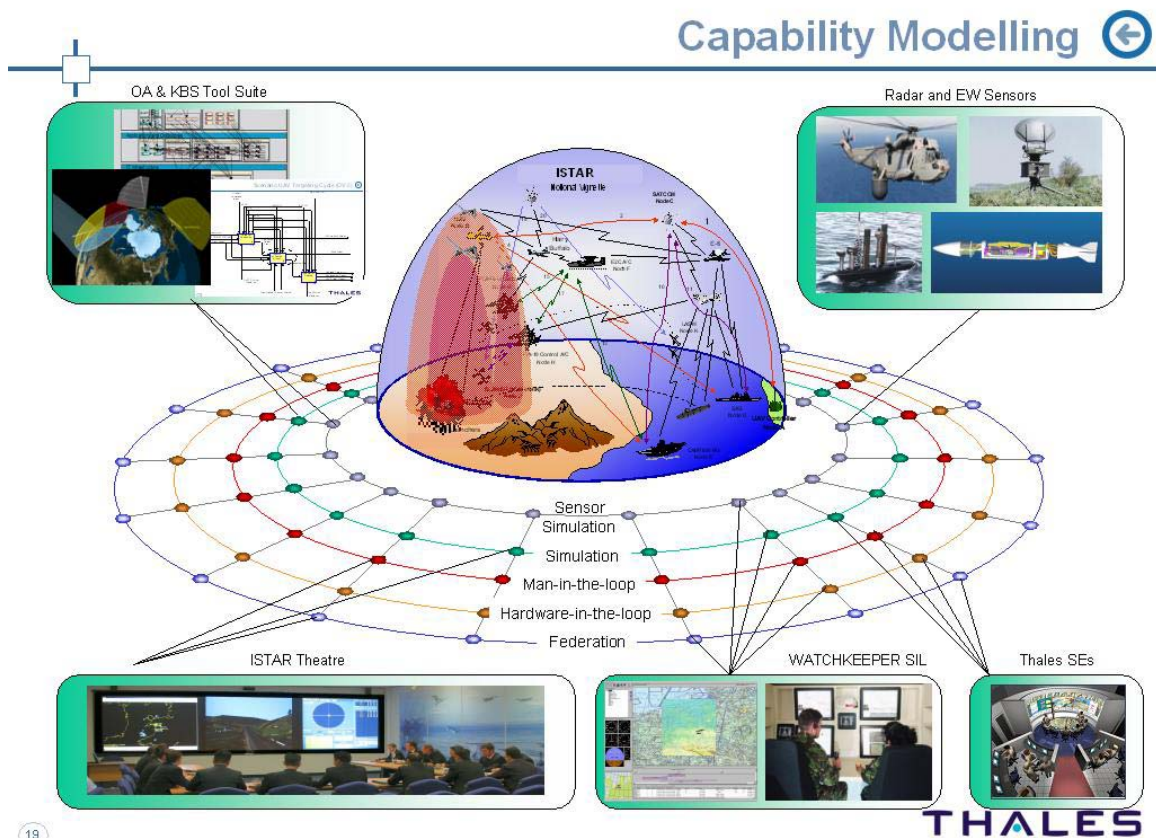
The demonstration test will show the following;

- a) The ability of the UAV to track the airplane from a predetermined distance.
- b) The ability of the UAV to identify the airplane.
- c) The ability of the system to display an ATC picture on the controller display in the GCU.
- d) The ability of the UAV to extend the voice communication range of the ATC. The pilot will execute the instructions which will then be observed by the UAV and transmitted to the GCU.

Control and Guidance of the airplane by sending command data from the ground via the UAV which will be displayed in the cockpit. The pilot will follow the command which will be detected by the UAV and transmitted to the GCU.

#### 4. AIR TO AIR COMMANDS FOR AUTOMATIC LANDING OF AIRCRAFT

This mode of operation includes supply of real-time information for local aircraft landing commands and efforts. Therefore data with high spatial and temporal resolution is needed. Timely information concerning the landing phenomena, which may provide strong indicators of a forthcoming accident, can often help to track and identify potential zones that may be hardest hit. The command mode of operation and landing is governed by GUIDEKEEPER Capability Modelling (similar to the “Watch keeper” capability) as described hereby. It is essential then to support prevention measures by estimating landing affordability and potential risks, which takes into account both passengers comfortably landing in opposite to potential vulnerability: the first being a measure of the degree of human satisfaction and property gain, and the second the probability of occurrence of critical conditions, which would trigger the accident start. Efficient monitoring is thereafter a fundamental necessity during the landing and post-landing phases. The challenges to be faced include the real-time information availability on the landing phase, the aircraft position, etc. The system requirements include a spatial resolution of less than 1m, coverage between 20 and 100 km<sup>2</sup>, a long time observation period and revisiting time of less than 1 hour and possibly a permanent observation.





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## **5. GUIDEKEEPER FOR IMPROVING AIR TRAFFIC MANAGEMENT**

Middle East is subject to different air traffic monitoring needs. The pictures in the front page give the expected radar and remote sensing requirements for improving the air traffic monitoring, control and management that could apply to a HALEAS-High Altitude Long Endurance Aircraft System- as function of degree of affordability increase to be achieved.

Application of preceding principles to HALEAS ATM missions:

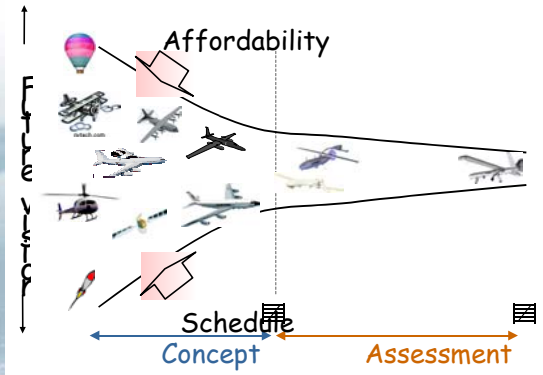
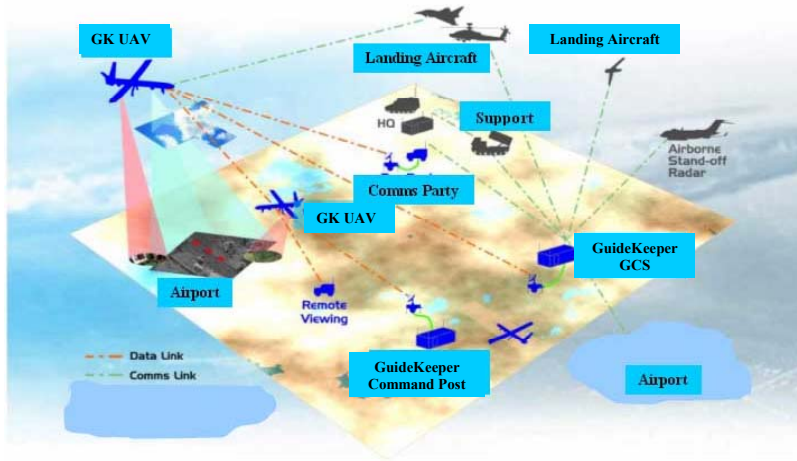
- In managed airspace: traffic will be handled as normal traffic
- If not certified, special waivers required, resulting perhaps in ATC workload increase
- Needed at least to cross airspace used by conventional traffic (low traffic periods possible)
- If certified to performance level of manned aircraft
- If Free Flight airspace: autonomous separation; ground to exercise “management” of density, plus possibly some overall surveillance “see/sense and avoid” for all non-segregated airspace, currently generally up to FL660, but traffic almost nil above FL500! Segregated airspace may be a viable option.
- Energy consumption for permanent real-time use.
- Remote communication platform
- Other sensors (weather, emissions)
- ATM and HALEAS
- ATM can accommodate HALEAS now, segregated airspace, ASM
- Specific contingency procedures
- Performance: H and V speeds – ATM can accommodate a broad range
- Range of mission (multi-sector implications?)
- Duration of control to be exercised
- Flight plan (main, contingency)
- necessary ATM regulations to/from segregated airspace
- Topics for work /Issues raised by HAPs
- ATM Regulatory Framework – sense/see & avoid
- Manned/unmanned transparency
- Technical systems; CNS; ACAS; Spectrum
- Deployment scenarios–planning; Safety/Security/Legal
- Airspace efficiencies; Standardisation; Licensing
- Airworthiness - Operational Approval

Following is a schematic presentation of ATC and ATM scenarios by using HAP as Guidekeeper similar to Watchkeeper scenarios.



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## 6. GUIDEKEEPER THE MIDDLE EAST SINGLE SKY TOWER

The original Sky Tower program developed and tested by AV-AeroVironment intends to deploy telecom backhaul in the sky for broadband, mobile and broadcast telecommunications. Other Sky Tower applications were considered for Homelad Security, disaster management etc. Hereby the high altitude Sky Tower is considered for airport tower applications to improve the Air Traffic Management and Flight Safety of aircraft in airports.

Following is presented the future vision of the Middle East Single Sky Tower concept.

**SkyTower**  
Telecommunications

**Applications**

- Fixed Broadband
- 3-G Mobile
- Narrowband
- Direct Broadcast

**Attributes**

- Low Cost, Scalable
- High Capacity
- Exceptional Coverage
- Rapidly Deployable
- Reliable / Maintainable
- Upgradeable

**LOCKHEED MARTIN**  
**High Altitude Airship**

High Altitude Airship (HAA)

Standard Missile Intercepts

PAC-3 Intercepts

E-2C

Angle Receiver: Cue and Tracks

Standard Missile Launch

Standard Missile Launch

**SkyTower High Altitude Platform Stations (HAPS)**  
for Wireless Broadband & Other High-Value Applications

**Global Observer HALE UAV**

Revolutionary Technology for Bridging the Last-Mile

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## 7. PROJECT DETAILS

### 7.1 Proposed Flight-tests in Europe with GUIDEKEEPER test-bench to be performed in Middle East airports

It deals with the testing and validation of the applicability of the GUIDEKEEPER test-bench for prospective services for guidance and control of vehicle flight application fields with the DLR flight test ATTAS airplane. Two different applications are pursued: detection and tracking of transport aircraft and monitoring, guidance and control activity. Two experiments of the GUIDEKEEPER test-bench will be organized. The experiment for detection and tracking of transport aircraft will be organized in Sardinia segregated airspace airport/site (Italy) and the experiment for the guidance and control of vehicle flight activity probably in the same site. The GUIDEKEEPER test-bench is based on the HERON high altitude UAV, equipped respectively with surveillance radar, with SAR, MTI, EO, IR and Laser sensors, with data-links including communication relay. It will also include the DLR space-borne bi-spectral BIRD sensor installed in the ATTAS flight test airplane and will also integrate information from ground sensors.

These field-tests with the GUIDEKEEPER test-bench must be planned and organized. Therefore, the objective of WP7 consists of acquiring all the data, which are necessary to achieve the goal of this project, i.e. to provide improved air flight management with major control capability in case of total automation guidance and control monitoring with prospective services. This work includes:

- a. the selection of the test sites, taking the end-users' requirements into account;
- b. preparation of the flight part of the experiments, which includes the flight planning, permission and preparation of the UAV,
- c. preparation of the ground part of the experiments including the planning of the experiment, preparation of the ground sensors and collection of data such as ground control points and geographic information; the experiment will require preliminary partial tests of the sub-systems of GUIDEKEEPER test-bench,
- d. the collection of the sensor data (MTI, SAR, EO/IR, etc) on the selected sites;
- e. the collection of truth test data,
- f. the processing, fusion and distribution of the data recorded with the airborne and ground-based sensors in field-simulated scenarios in the airport sites.
- g. the analysis and validation of the data recorded by the GUIDEKEEPER system for detection, tracking and monitoring of aircraft flight trajectory.

The images hereafter provided by IAI give an overview of the sensor capacity of the HERON system.

#### **Demonstration objectives**

The demonstration test will show the following;

- The ability of the UAV to track airplane from a predetermined distance.
- The ability of the UAV to identify the airplane.



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- The ability of the system to display an ATC picture on the controller display in the GCU.
- The ability of UAV to extend a voice communication range of the ATC. The pilot will execute the instructions which will then be observed by the UAV and transmitted to the GCU.
- Control and Guidance of the airplane by sending command data from the ground via the UAV which will be displayed in the cockpit. The pilot will follow the command which will be detected by the UAV and transmitted to the GCU.

### **General**

Equipment:

- HERON UAV with ATC transponder
- GCS (Ground Control System) for UAV
- GDT (Ground Data Terminal)
- General Aviation airplane

Test area:

- Up to 30000 ft alt.
- Up to 50 km range (radius) from base

Test pattern and procedures:

- To be coordinated with the airbase
- Obtain airbase traffic control information

### **Operating personnel**

The UAV system will be operated by qualified crew members:

- Mission Commander
- Internal Pilot
- External pilot
- Technicians

### **Normal Procedures - Takeoff**

T-180 Minutes:

- UAV Pre-flight checks inside hangar end
- GCS Pre-flight checks end

T-90 :

- Flight crew briefing by Mission Commander

T-60:

- Flight crew begin normal procedures in GCS

T- 30:

- Mission commander requests permission from Tower to occupy the runway while indicating runway in use
- External pilot will position flight equipment on runway shoulder

**REMARK: FROM THIS POINT THE RUNWAY IS USED ONLY FOR UAV OPERATION**

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T-10:

- Mission commander requests permission from Tower to line up for takeoff

REMARK: TAKEOFF DISTANCE IS BETWEEN 500 – 600 METERS AND WILL VARY ACCORDING TO TAKEOFF WEIGHT AND WIND CONDITIONS.

T-1:

- Mission commander requests permission for takeoff

T+10:

- External pilot clears his post and removes flight equipment from the runway to approximately 5 meters away from runway shoulder
- Mission commander will notify Tower that the runway is clear

REMARK: FROM THIS POINT THE RUNWAY IS OPEN FOR GENERAL USE

Option A: over the head depart/approach

- External Pilot will climb to appx.1000' AGL while performing a TBD circuit pattern
- Then control will be transferred into the GCS
- UAV will climb to TBD' AGL
- Then UAV will depart on route to the holding circle while climbing to TBD' ASL
- Then UAV will fly to test area

NOTE: DETAILS WILL BE COORDINATED WITH BASE

Option B – direct depart/approach:

- EP will climb to appx.300 feet AGL
- Control then will be transferred into the GCS
- UAV will climb to 1st wp of departure route
- Then UAV will continue to climb in route flight to holding circle at TBD' ASL
- Then UAV will fly to test area

NOTE: DETAILS WILL BE COORDINATED WITH BASE

**Normal Procedures In-flight**

- UAV will fly within Restricted Area or TBD zones
- UAV will change course according to Tower advice
- Mission commander will maintain a continuous two-way TBD radio communication with Tower and will be listening to it via TBD radio while UAV is airborne
- Mission commander will notify Tower about every intended change in course or altitude and will perform the change only upon approval





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### **Normal Flight Procedures – Landing**

L-15 minutes:

- Mission commander will request permission from Tower to descend for landing and to use the runway
- Upon approval the External Pilot will position flight equipment on runway shoulder

**REMARK: FROM THIS POINT THE RUNWAY IS USED ONLY FOR UAV OPERATION**

L-2:

- Mission Commander will report Tower upon entering down wind leg and will verify permission to land

L+1:

- After landing procedures including engine cut off

L+5:

- External pilot will clear his post and will remove flight equipment from the runway to about 5 meters from runway shoulder
- UAV will be towed to hangar
- Mission Commander will notify Tower that the runway is clear

**REMARK: FROM THIS TIME THE RUNWAY IS OPEN FOR GENERAL USE**

### **Emergency procedures – general guidelines**

- In the event of an emergency situation, the Mission Commander will notify Tower
- In the event of an avionic system failure (computer, power supply, navigation system) the UAV will RTB ASAP using the backup unit according to the normal traffic procedures
- In the event of an engine failure the UAV will be flown to the base in an emergency landing procedure.
- In the event of engine failure and comm. failure the UAV will perform an emergency landing, autonomously, in a pre-planned emergency place.
- In the event of total uplink failure the UAV will fly autonomously to its no-comm route. This route ends at the holding circle at TBD over unpopulated area.

### **Tactical Communication**

- All communication with authorities will be performed by the Mission Commander.
- The Mission Commander will communicate with the UAV ground crew using a VHF handset
- The Mission Commander will communicate with the Tower via TBD set

## **7.2 Air traffic control and management field-tests**

GUIDEKEEPER capability for providing with prospective Air Traffic Management & Control affordability for given airport related to traffic monitoring improvement must be demonstrated. Therefore, existing recorded data will be analyzed and tools to be implemented and integrated in a prospective GUIDEKEEPER system will be developed to demonstrate the high benefit of a



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GUIDEKEEPER system to monitor and manage air traffic control above the airport nearby LOMBARDSIJDE and ELSENBORN in Belgium.



### Emergency procedures after takeoff to TBD

- A map will be prepared to show route based on airbase information

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### Air traffic control above an airport

The main goal of this mode of the GUIDEKEEPER operation consists in wide area scanning from the air of the airspace above the airport: 1) to detect from very long range in all weather conditions aircraft approaching the airport (civil, military and private); 2) to identify friend or foe aircraft flight objective; 3) to verify aircraft flight destination; 4) to track incoming aircraft and provide relevant information to the airport; 5) to compute and assess the four dimensions trajectory of the aircraft by on board data processing and by data transmission to the airport computer centre.

In this project the following systems will be involved in performing the air-to-air detection and tracking mode of operation:

- 1) The HERON high altitude UAV equipped with a surveillance type radar as following described, with high rate data link transmitter to provide relevant information to the airport, and with 28-35 GHz relay for deploying a communication backhaul in the sky in emergency situation.
- 2) Airport/ground communication and command stations, and computer centre as described later. The challenges to face for spatial information of incoming aircraft include: (i) very long range detection of incoming aircraft giving the opportunity for tracking and providing additional security context for the incoming aircraft; (ii) synthetic flight pattern maps to cover many and large regions with early warning information when required (iii) once landing starts: detailed spatial information over a small area, typically 10x10 km<sup>2</sup> at high resolution to give air traffic controllers extra time for risk decisions if needed. Each decision context requires an adequate



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level of information granularity. Regional and airport risk assessment must be consistently combined with on-demand local assessment.

The challenge to face for the time scale: (i) before potential accident starts: a long-term risk prevention planning, short-term risk mapping, preparedness, accident detection; (ii) once a landing starts: a quick local mapping, monitoring of landing commands and tracking of flight trajectory position, information updating must be adequate to the decision making context if required.

It is obvious that a GUIDEKEEPER system is best suited to fulfil all of these tasks of the flight security additions.

### **Traffic control application**

The detection and characterization of objects in the airport areas relevant to air traffic monitoring is a well-known application of SAR and airport radar and sensors. Areas covered with moving targets are easy to recognize in SAR because of their very low response in the X-band in vv polarisation. Nevertheless, full polarimetric and interferometric SAR measurements could enhance efficiently the confidence in the detection and the characterization of airport objects aiming to improve the ATM affordability.



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## **8. SCHEDULE AND BUDGET**

8.1 The design and feasibility test project will prolong 24 months and the total working effort/cost of the flight test project in the five airports CAIRO-RIYADH-AMMAN-BEN GURION-ISTANBUL will be \$20 Million. The main purpose is to establish the relevant specifications and requirements in each airport in order to develop and deploy at next phase a Guidekeeper system with operational capabilities relevant to each airport.

8.2 The launching of an operational GUIDEKEEPER system thereafter above each airport will cost approximately \$0.5 Billion per airport and will prolong 3 years.

## **9. REFERENCES**

- (1) A. Lavie, D. Penn, P. Hendrick, H. Suess, T. Tozer and C. Barbier “Improving Air Traffic Management by Using HAAS (High Altitude Aircraft System)” – FP6-2002-AERO-2 SSA Project, Contract No.516081 USE HAAS, Deliverable D10, January 2007, published in <http://www.usehaas.org>
- (2) R. Browning “The US High Altitude Airship Program”, Lockheed-Martin MS2 Acron USA, USE HAAS Deliverable D4, October 2005, published in <http://www.usehaas.org>
- (3) Stuart Hindle, AeroVironment California USA, and Yuichiro Nishi, Sky Tower Japan, “The USA AeroVironment Helios, Path Finder, Global Observer UAV’s” USE HAAS Deliverable D4, October 2005, published in <http://www.usehaas.org>