

# **Future Applications of UAVs**

## **INPUTS TO JAA/EUROCONTROL TF**

**JAA, Hoofddorp, 2003-05-08**

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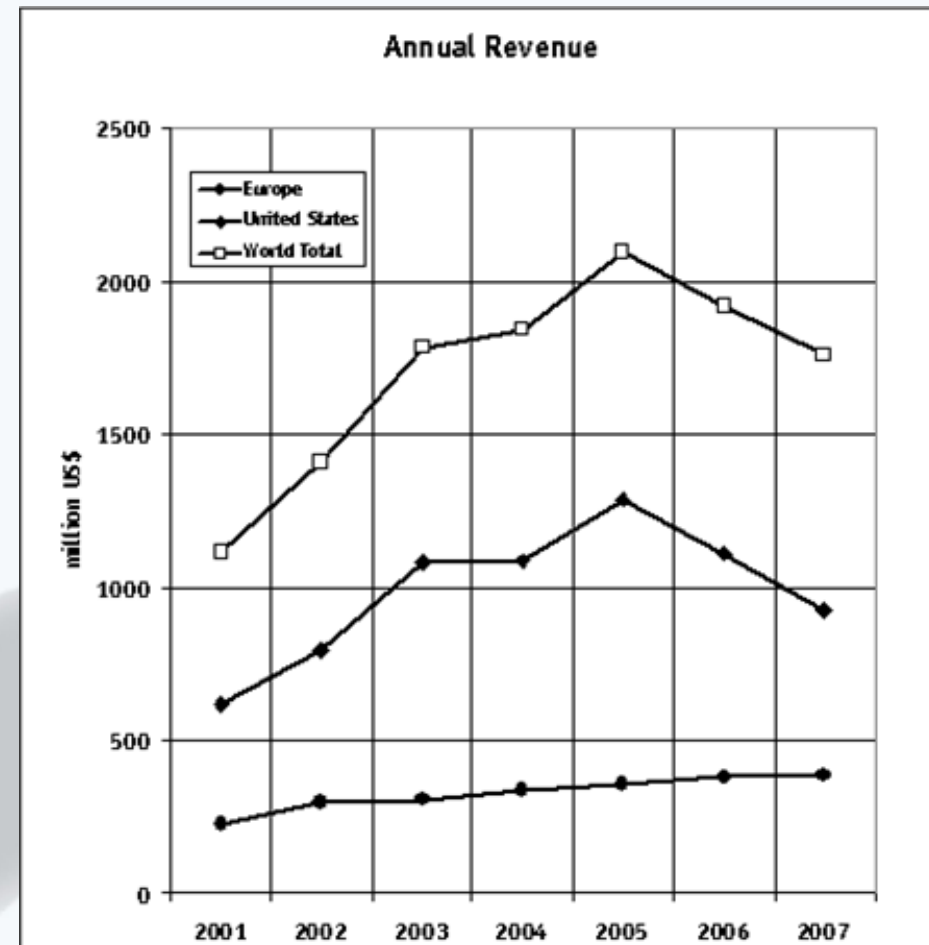
**airobotics GmbH, Germany  
NLR, Netherlands  
DLR, Germany  
IAI, Israel  
Swedish Defense College, Sweden  
University of Naples, Italy  
Marconi Mobile, Italy  
ONERA, France  
EADS, France  
Swedish Space Corporation, Sweden**

## Overview

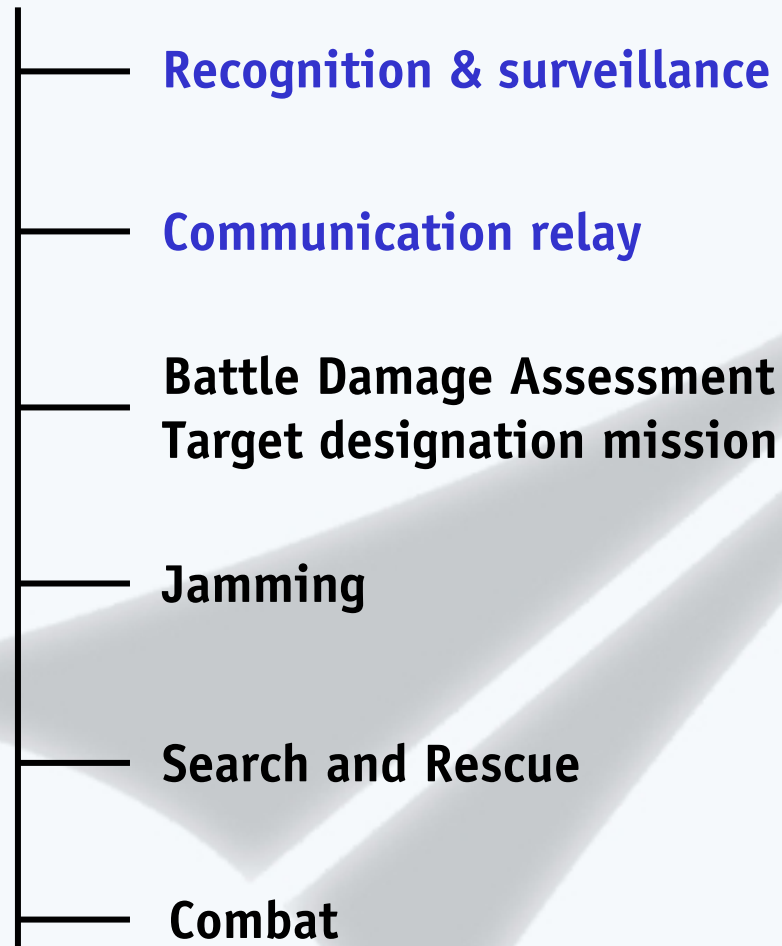
- **MARKET FORECAST**
- **MILITARY APPLICATIONS**
- **CIVIL APPLICATIONS**
- **MARKET RESTRAINTS**
- **MARKET DRIVERS**
- **MARKET ENTRY CANDIDATES**
- **CONCLUSIONS**

## Market forecast

- World market for UAV systems reached approximately EUR 1.1 billion in 2001.
- Annual growth rate forecast of appr. 7 % for the period 2001 – 2007 [Frost2002].
- 90+ % of all funding for UAV systems are directed to national military and defence programs.



## Overview of MILITARY application areas



blue – dual use

## Military applications - platforms

- HALE and MALE can be multi-payloads and multi-missions (due to the payload capacity),
- the other UAVs are multi-payloads but mono-mission, but different types of payloads can be installed in the same Air Vehicle,
- Similarities to civil systems
  - The UAV has to be able to be integrated in the military Air traffic and in the civil Air traffic for the use in peace period,
  - The UAV has to be interoperable with other systems.

MISSIONS	HALE	MALE	SR TACTICAL	VTOL
Information & Documentation mission	X	X		
Recognition & Surveillance	X	X	X	X
Target designation		X	X	X
Jamming		X		X
BDA		X	X	X
Communication relay	X	X	X	X
Measurement of environment characterisation	X	X	X	X
Search & rescue		Search	X	X

## Overview of CIVIL application areas



**blue – dual use**

## Major market restraints

- **Lack of airspace regulation for UAV systems holds back market growth and opportunity,**
- **Insurance for civil operation is expensive and difficult to obtain,**
- **Lack of a secure non-military frequency for civil operation,**
- **Poor understanding of the costs of operation, support and training,**
- **Military marketing does not address civil markets,**
- **Restriction to proliferation according Missile Technology Control Regime,**
- **Cheaper operation of manned aircraft in civil missions.**

## Major market driver

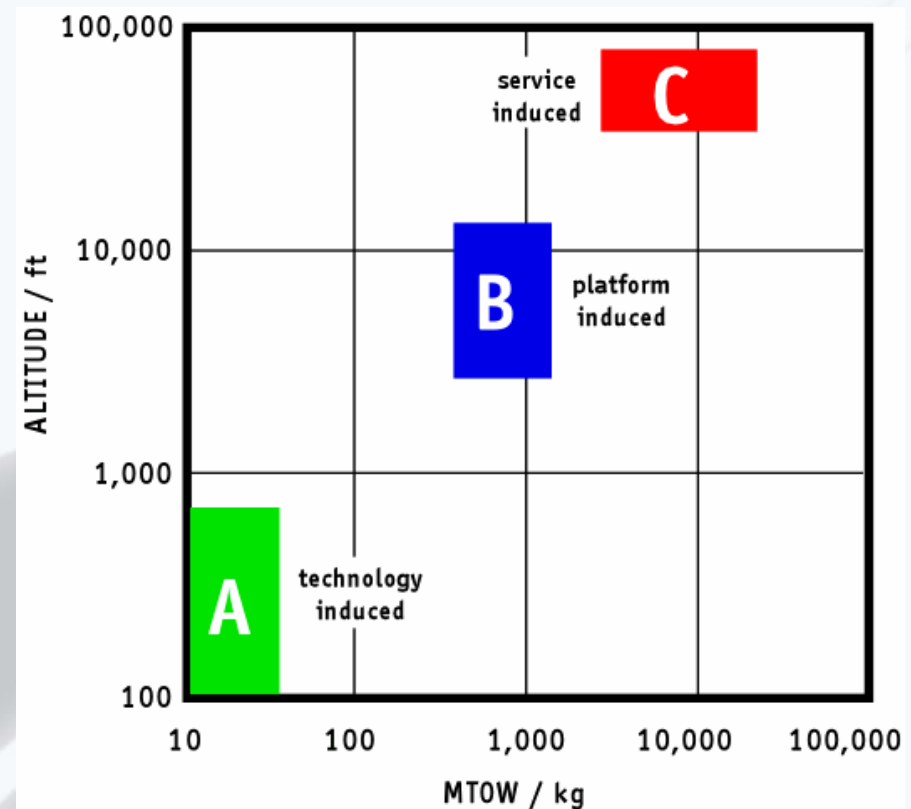
- Increasing success in service and visibility,
- Growth in high-level political support will accelerate funding of UAV programs,
- Rising frequency of demos points to arrival of new users and market expansion,
- Increasing payload capability and modularity brings critical capabilities to market,
- Suitability of use in "dull, dirty and dangerous" missions evidences a growing demand driven market,
- Unique flight envelopes.



## Market entry candidates - overview

### Criteria for candidate selection:

- Target market characteristics (volume, growth etc)
- Target service properties (quality, cost etc)
- UAV related aspects (flight envelope, payload capability, regulatory aspects etc.)



## Market entry candidates - **TECHNOLOGY INDUCED (A)**

- MiniUAVs at low altitude,
- Future applications for this type of platform will be driven by the technological improvement of platform and payload,
- Pushed by research centres, universities, small and medium sized enterprises,
- Niche applications will be offered the total market volume will remain small.

PROS	CONS
<ul style="list-style-type: none"> <li>+ high cost efficiency</li> <li>+ easy operation</li> <li>+ existing regulations</li> <li>+ low impact in case of emergency</li> <li>+ low cost market segment</li> </ul>	<ul style="list-style-type: none"> <li>- low market volume</li> <li>- operations in LOS</li> <li>- no use above populated areas</li> <li>- low/medium quality of service</li> </ul>
<b>MOST PROMISING APPLICATIONS:</b> <ol style="list-style-type: none"> <li>1. aerial photography / visual inspection</li> <li>2. advertising / entertainment</li> <li>3. crop spraying</li> <li>4. scientific missions</li> <li>5. de-mining</li> <li>6. environmental monitoring (agriculture)</li> </ol>	
<b>TYPICAL PLATFORMS:</b> <ul style="list-style-type: none"> <li>▪ Aerosonde, Aerosonde Ltd., AUS (fixed wing)</li> <li>▪ Seascan, InSitu Inc., USA (fixed wing)</li> <li>▪ Camcopter, Schiebel Elektronische Geräte GmbH, A (rotorcraft)</li> <li>▪ R50, R-max, Yamaha Motor Company Ltd, J (rotorcraft)</li> </ul>	

## Market entry candidates - **TECHNOLOGY INDUCED (A)**

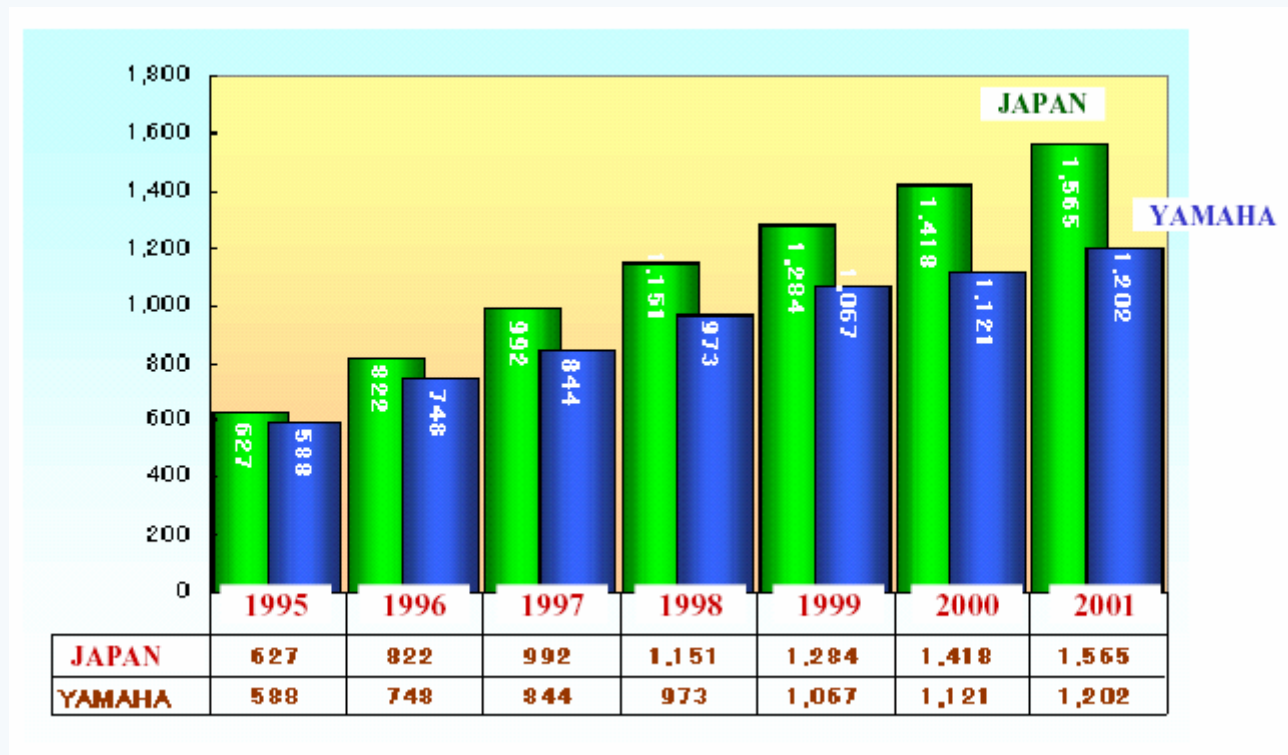
### EXAMPLE: Yamaha R50/RMAX



	<b>R50</b>	<b>RMAX</b>
Main Rotor Diameter(mm)	3,070	3,115
Tail Rotor Diameter(mm)	520	545
Overall Length(mm)	3,580	3,630
Overall Height(mm)	1,080	1,080
Overall Width(mm)	700	720
Empty Weight(kg)	47	64
Payload(kg)	20	30
Engine		
Displacement(cc)	98	246
Category	Water Cooled 2 Stroke	
Maximum Output(KW)	8.8	15.4

## Market entry candidates - TECHNOLOGY INDUCED (A)

Example: Yamaha R50/RMAX



**More than 1.500 registered unmanned rotorcraft  
for agricultural use in Japan.**

## Market entry candidates - PLATFORM INDUCED (B)

- **MALE platforms,**
- **Market segment is driven by existing platforms and existing operational experience from the military field,**
- **Established military UAV manufacturer and system integrator will play a dominant role,**
- **Typical customers are institutional organisations (government, national research centres etc.).**

PROS	CONS
<ul style="list-style-type: none"> <li>+ existing platforms</li> <li>+ existing operational experience</li> <li>+ high payload capability</li> <li>+ quality of service (high resolution, high coverage in time)</li> </ul>	<ul style="list-style-type: none"> <li>- low cost efficiency</li> <li>- operations beyond LOS</li> <li>- integration in the existing air traffic</li> <li>- no applicable solutions for see &amp; avoid</li> <li>- restricted use above populated areas</li> <li>- restriction in proliferation</li> </ul>
<b>MOST PROMISING APPLICATIONS:</b> <ol style="list-style-type: none"> <li>1. Governmental (sovereign) tasks <ul style="list-style-type: none"> <li>- border control, coastal control, restricted area control</li> <li>- disaster monitoring, environmental monitoring</li> </ul> </li> <li>2. Scientific missions</li> <li>3. Infrastructure monitoring <ul style="list-style-type: none"> <li>- pipelines</li> <li>- power lines</li> </ul> </li> <li>4. Surveying</li> </ol>	
<b>TYPICAL PLATFORMS:</b> <ul style="list-style-type: none"> <li>▪ IAI Hunter</li> <li>▪ EADS Eagle</li> </ul>	

## Market entry candidates - PLATFORM INDUCED (B)

### EXAMPLE: EADS EAGLE



Wing span	21 m
Weight:	1.400 kg
Altitude:	45,000ft
Duration:	30 hours
Payload weight:	450 kg

## Market entry candidates - PLATFORM INDUCED (B)

### EXAMPLE: EADS EAGLE

	EADS EAGLE	LOCKHEED MARTIN ER-2	M-55 Geophysica
payload capacity/kg	450	1,180	1,500
max. altitude/ft	45,000	> 65,000	72,000
price per hour/EUR	16,000 - 8,000  Eur 800,000 for a three- week cam- paign with 50-100 flight hours planning	20,000  During pre- booked cam- paigns, not including cost for relocating	6,000  During a pre- booked cam- paign, not in- cluding cost for relocating. In- tegration of new instru- ments 1 MEUR and is to be ordered one year in ad- vance.

## Market entry candidates - **SERVICE INDUCED (C)**

- **HALE geostationary platforms**
- **Focus on the requirements of future telecommunication system (broadband network, mobile network, fixed network),**
- **Market segment will be dominated by telecom service providers, telecom infrastructure manufacturers and system integrators,**
- **High market volume (development cost approx. 200-400 MEUR, system costs 20-40 MEUR.**

PROS	CONS
<ul style="list-style-type: none"> <li>+ high cost efficiency</li> <li>+ high market volume with remarkable growth rates</li> <li>+ quality of service (coverage, re-configuration for traffic adaptation)</li> <li>+ simple operational scenario (LOS, station keeping above the air traffic)</li> </ul>	<ul style="list-style-type: none"> <li>- no existing platforms</li> <li>- reduced availability of services in case of critical environmental conditions in the stratosphere</li> <li>- operations above highly populated regions</li> </ul>
<b>MOST PROMISING APPLICATIONS:</b> <ol style="list-style-type: none"> <li>1. broadcast</li> <li>2. fixed services / last mile</li> <li>3. mobile communications</li> <li>4. location based services</li> <li>5. environmental monitoring</li> </ol>	
<b>TYPICAL PLATFORMS:</b> <ul style="list-style-type: none"> <li>▪ High altitude long endurance aerostatic platform, European Space Agency, (aerostat)</li> <li>▪ SkyNet ,J, (aerostat)</li> <li>▪ HeliNet, Politecnico di Torino, I, (fixed wing)</li> <li>▪ Helios, Aerovironment, USA (fixed wing)</li> </ul>	



## Market entry candidates - **SERVICE INDUCED (C)**

### System overview of aerostatic platform for telecommunications

#### Design

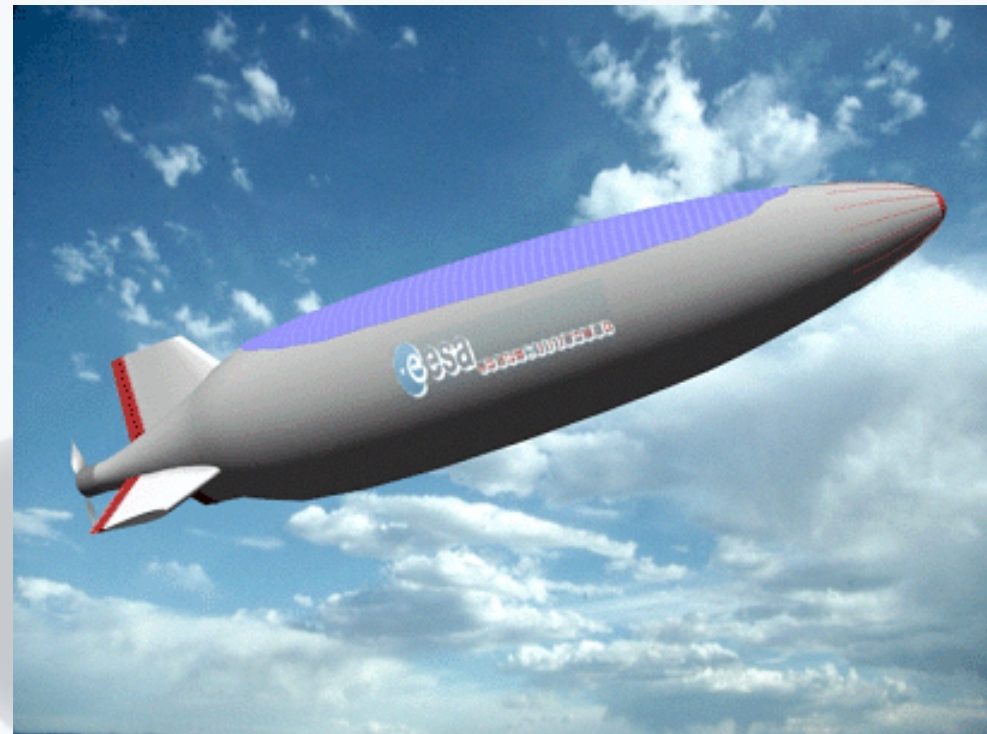
- Non-rigid structure
- stern propeller gimballed
- DC-Engine brushless
- Thin-film solar cells
- Regenerative fuel cell

#### Performance

Altitude:	21.000 m
Speed:	25 m/s
Mass <sub>payload</sub> :	1.000 kg
Energy <sub>payload</sub> :	10 kW

#### System characteristics

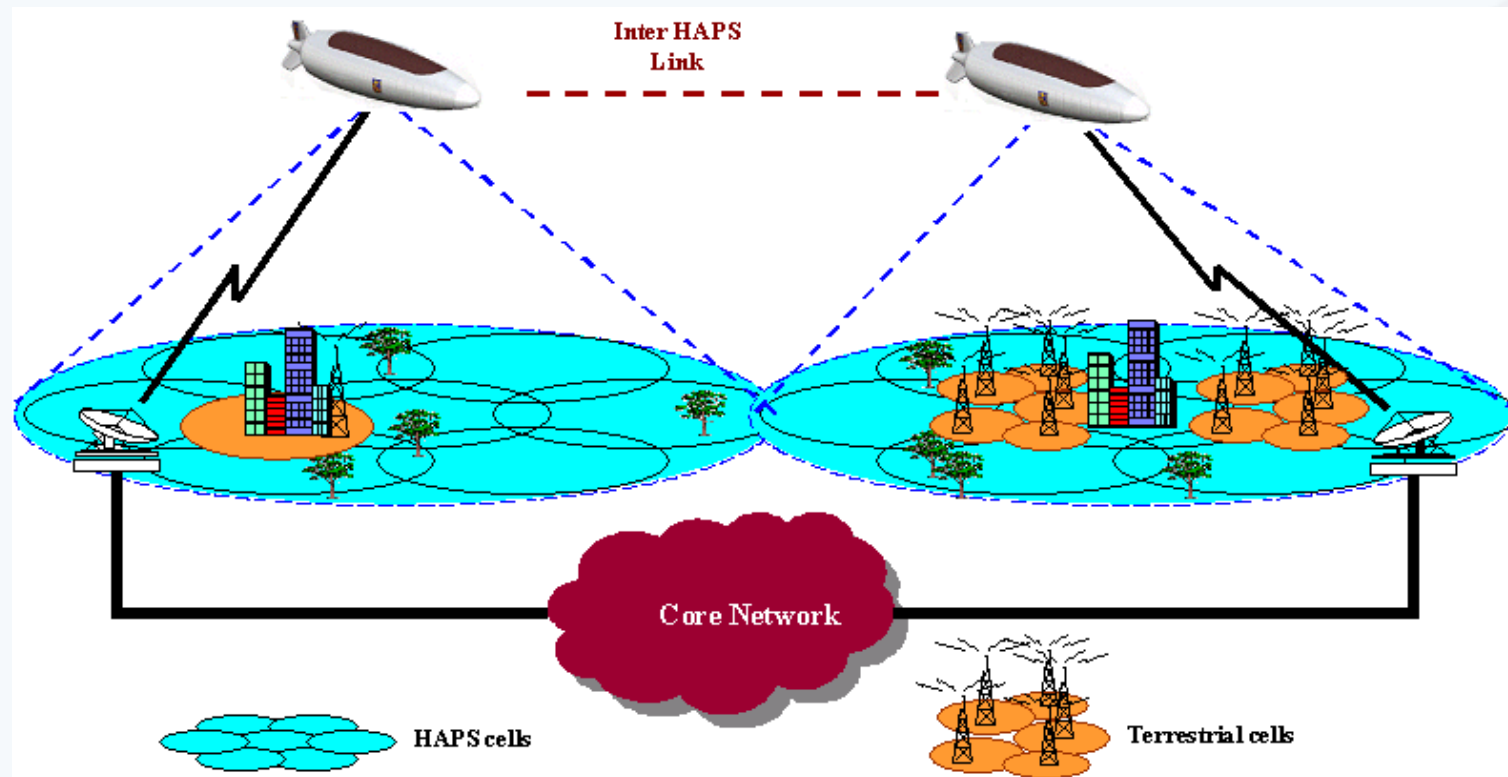
Length:	220 m
Diameter:	55 m
Mass <sub>total</sub> :	20.800 kg
Volume:	320.000 m <sup>3</sup>
Propulsion:	90 kW



esa - HALE

## Market entry candidates - **SERVICE INDUCED (C)**

### Telecommunication Infrastructure Architecture



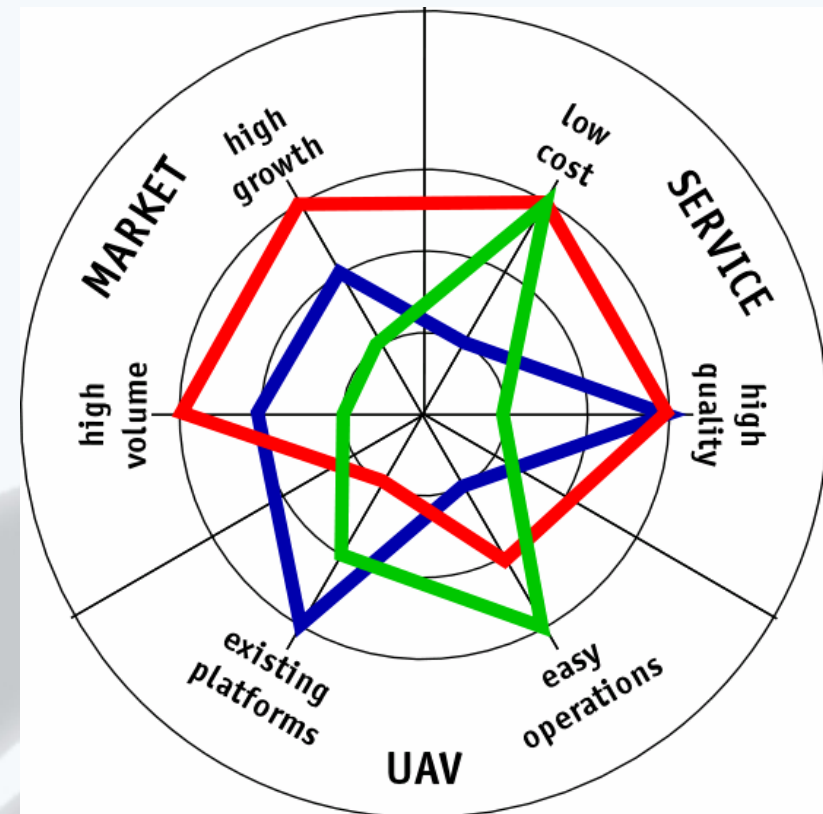
## Market entry candidates - SERVICE INDUCED (C)

### Comparison of different infrastructure

issue	terrestrial	satellite	stratospheric platform
<b>Deployment timing</b>	Deployment can be staged; substantial initial built-out or provide sufficient coverage for commercial services.	Service cannot start before the entire system is deployed.	One platform and ground support typically enough for initial commercial service.
<b>System growth</b>	Cell splitting to add capacity, requiring reengineering; easy equipment update/repair.	System capacity increased only by adding satellite; hardware upgrade only with re-placement of satellites.	Capacity increase through spot-beam re-sizing, and additional platforms; equipment upgrades relative easy.
<b>Indoor coverage</b>	Substantial coverage achieved.	Generally not available.	Substantial coverage possible.
<b>Geographical coverage</b>	A few kilometres per base station.	Large regions in GEO; global for LEO and MEO.	Hundreds of kilometres per platform
<b>Terrain shadowing</b>	Causes gaps in coverage; requires additional equipment.	Problems only at low elevations	Similar to satellites

## Market entry candidates - SWOT analysis

- Market entry segments will develop independent and different,
- Telecom applications is the most promising candidate.



miniUAV – MALE – HALE

## Market entry candidates -Timeline

- **miniUAVs** are used for niche applications,
- **MALE** will be used for non-military governmental applications in the midterm,
- **HALE** telecom applications are expected in the long term.

REF. APPLICATIONS	short term	mid term	long term
<b>Case A:</b>			
- visual inspection			
- advertising/entertainment			
- crop spraying			
- scientific missions			
- de-mining			
- environmental monitoring (local areas)			
<b>Case B:</b>			
- border control			
- costal control			
- scientific missions			
- infrastructure monitoring			
- surveying			
<b>Case C:</b>			
- broadcast			
- fixed services			
- mobile communication			
- location based services			
- earth observation			

## Conclusions

- **Military applications will dominate the future of UAVs. U.S. Department of Defense will spend US\$ 10 billion by 2010 to quadruple their today's UAV inventory.**
- **To trigger high growth in sales and use, UAV-industry is trying to expand partly in civil market areas such as global monitoring of environment and security (GMES), homeland defence and communications.**
- **UAV manufacturers have to improve the existing military platforms or to develop dedicated UAVs to meet the requirements of the civil market. Cost efficiency, easy operations and reliability are the main design drivers for future civil UAVs.**