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ENTERPRISE AND INDUSTRY DIRECTORATE-GENERAL

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STUDY ANALYSING THE CURRENT ACTIVITIES IN THE FIELD OF UAV

First Element: Status

"Where are we today – the industrial/economical/political situation in Europe and the international interdependencies"

Table of Contents

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1. UAV Sector in Europe – Overview of the current situation

1.1. Overview

UAV use in Europe has been slower to emerge than in the US and in Israel. However, experience of using mature UAV systems on operations in Iraq and in Afghanistan has dramatically improved the European perspective on their utility, and the military market is growing at a significant rate.

Whilst it has been the major European military powers of UK, France, Germany and Italy who have taken the lead in the procurement of military UAVs, there are growing signs that their popularity is reaching a wider market. In the EU accession states, the Czech Republic, Poland and Romania are gaining significant experience on UAV operations; Hungary has experimented with UAVs in civil applications such as fire fighting and a number of SMEs with an interest in the area are emerging.

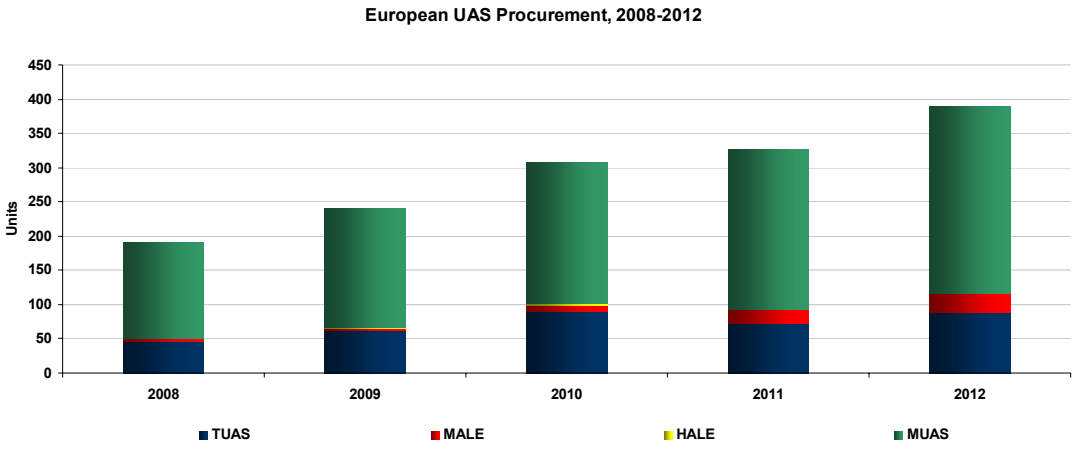
Military procurement was initiated principally by the conflict in the former Yugoslavia and, as a result, European forces have focussed on the tactical level UAV such as the Sperwer and Phoenix rather than choosing to acquire the full spectrum of UAV systems. The experience of using these tactical systems has been instrumental in shaping requirements for a broader range of UAVs, and in the development of CONOPS in their use. Over time, however, European military forces have progressively expanded their inventory of UAV systems to include mini-UAVs (in the case of UK, France, Germany, Sweden, Ireland, Italy, Spain, The Netherlands, Denmark, Poland and Norway), and MALE UAVs (in the case of UK, France and Italy). They have also been examining the potential for weaponising current UAV models as well as for acquiring UCAVs – Unmanned Combat Aerial Vehicles.

The success of UAVs in providing real-time information to commanders on the battlefield has contributed to both mission effectiveness and in protecting personnel. It is their effectiveness in these roles which has encouraged European countries to commit to the use of military UAVs to an extent that will support rapid market growth during the next ten years.

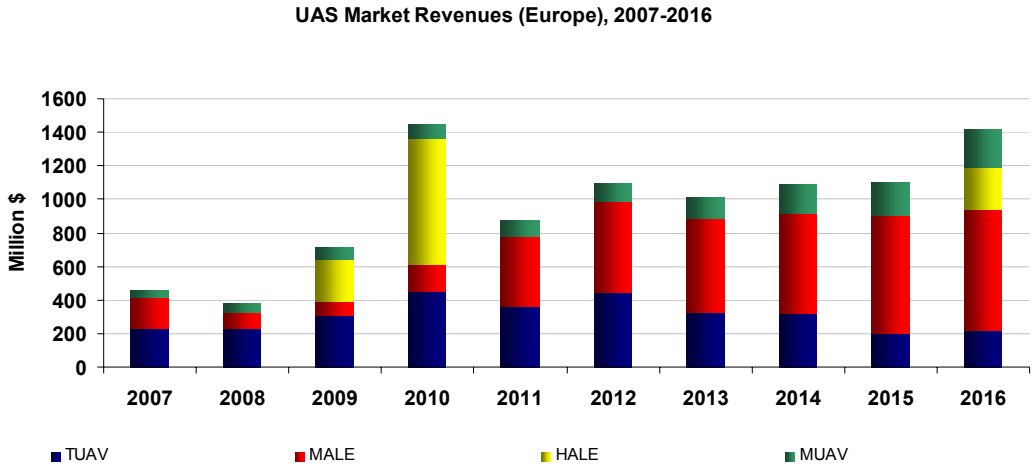
In many respects, it is this successful operational use that is causing problems for the development of the UAV industry in Europe. The industry has suffered

from a lack of research investment in a context where customers want mature, battle-proven equipment at low cost and in a short time frame, and national governments as well as EU institutions have often not done enough to support UAV development activities, especially in the civilian sector. This has encouraged European industry to focus on partnerships with Israeli or US companies at the expense of developing a native, European alternative. This trend has broad implications for the further development of expertise within the European skills base and the competitiveness of European companies in the emerging global marketplace.

European military UAV market



Source: Frost & Sullivan



Source: Frost & Sullivan

A notable characteristic of the rapid growth in the procurement of military UAVs over the forthcoming ten years will be the shift towards MALE category platforms. This shift poses a significant threat to European industry, which has

tended to focus on the tactical level. Between 2008 and 2016, the European Military UAV market is expected to see procurement of:

- Up to 600 tactical UAV aircraft
- Up to 200 MALE UAV aircraft
- 5 HALE UAV Aircraft
- ~10, 000 Mini-UAV aircraft

This corresponds to an estimated market value of around €8 billion up until 2016.

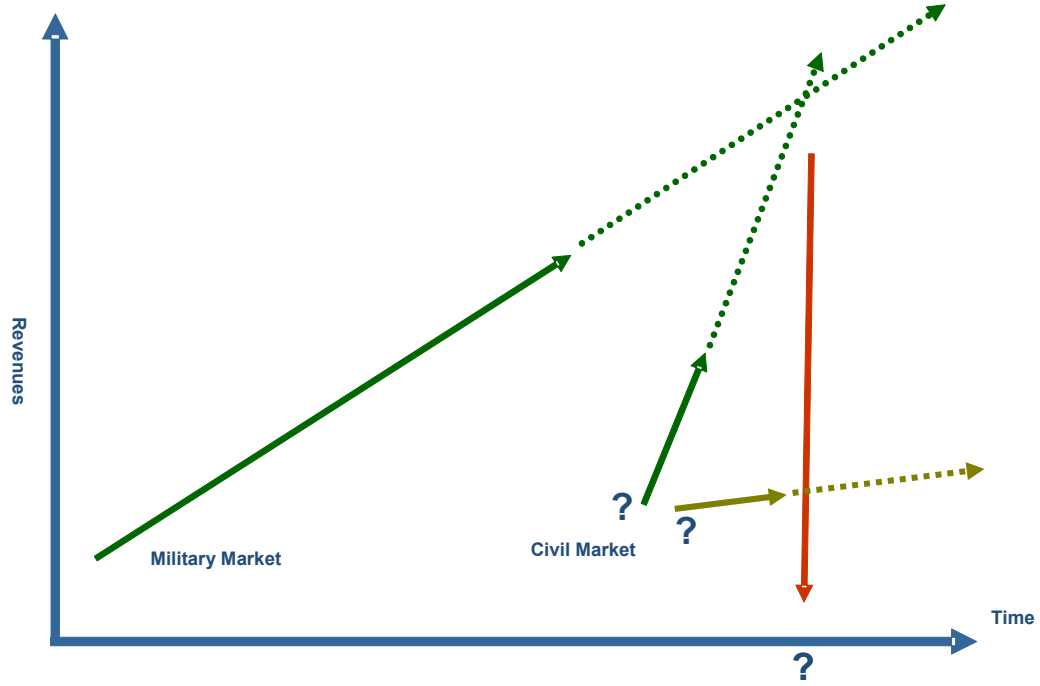
European civilian UAV market

European companies have shown a significant amount of interest in the potential application of UAVs in civil and commercial markets. In line with major prevailing trends across the defence sector, the military has acted as a first adopter of UAV systems and has demonstrated their utility, encouraging the idea of their use l in the following applications:

- Government
    - Law enforcement (Police, Civil Security)
    - Border security
    - Coastguard
- Fire and Rescue
    - Forest fires
    - Other major incidents
    - Emergency rescue (e.g. Mountain rescue)
- Energy Sector
    - Oil and gas industry distribution infrastructure monitoring
    - Electricity grids / distribution network monitoring
- Agriculture, Forestry and Fisheries
    - Environmental monitoring
    - Crop dusting
    - Optimising use of resources
    - Fisheries Protection
- Earth Observation and Remote Sensing
    - Climate monitoring

    - Aerial photography, mapping and surveying
    - Seismic events
    - Major incident and pollution monitoring
- Communications and Broadcasting
    - VHALE platforms as proxy-satellites
    - MALE / S/MUAS as short-term, local communications coverage
    - Camera platforms (e.g. broadcasting, and film industry)

Historically, industry has often been guilty of being unrealistically optimistic in predicting the rapid emergence of a viable civil and commercial UAV market, but has also played an effective advocacy role in driving initiatives in the area. It is evident that the potential of the civilian market is considerably larger than the military sector, although there are presently major constraints on this market emerging. At some point – once present obstacles have been overcome – it is expected that the civilian market will overtake the military market in value, but in the short term the military market is the only area where UAV manufacturers can achieve sustained revenues worthy of investment in product development and R&D.



The lack of a central procurement authority, the absence of legislation and regulations for safe flight in integrated airspace, combined with a diffuse

potential customer base has meant that initiatives in the use of UAVs in non-military applications have been relatively un-coordinated and ad-hoc in nature. Work has began in earnest to kick-start a market through a number of initiatives, although it is correct to note that there is currently no significant market for UAVs in civil and commercial applications in Europe.

Once restrictions on its emergence are finally swept away, the potential scale of the commercial market is likely to be much larger than the military market, however. There are multiple reasons for this, including:

- Military applications of UAVs have largely been developed and matured. Whilst it is expected that numbers in-service will increase dramatically, it is unlikely that there will be a dramatic transfer from manned aircraft to unmanned aircraft in the medium term.
- In the wide range of areas where it would be feasible to replace manned aircraft with UAVs, the market for non-military applications is much larger than the defence sector and includes:
    a. Police / Paramilitary / Security applications
    b. Agriculture spraying / planning
    c. Low Earth Orbiting Satellites
    d. Logistics / parcel delivery
    e. Commercial passenger transport
    f. Aerial photography

Nevertheless, it is clear that the emergence of UAVs in many of these sectors could take a considerable period of time, and whilst UAVs are set to have a considerable impact on the commercial market, growth will be consecutive, with different applications acting as first adopters.

State of play and Roadmap of Regulatory Change

As a new technology, there is currently little precedent for accommodating UAVs within the existing framework of rules governing routine flight in European non-segregated airspace. In order for this to happen successfully, a great deal of adjustment is necessary. Encouragingly, Europe is seen by many experts as being quicker in tackling these issues than the Federal Aviation Authority (FAA) in the United States.

A whole range of legislative and regulatory measures needs to be designed, mutually agreed, then drawn up and implemented. These rules will in turn be founded upon certain essential technologies, the most notable being a reliable, light, low-power and cost-effective Sense and Avoid (S&A) system, which would eliminate the possibility of a mid-air collision between aircraft: manned or unmanned.

The benchmark, or goal towards which legislators and industry alike are striving is that UAVs should be able to operate at an Equivalent Level of Safety to manned aircraft. Meanwhile UAVs are required to fly either in segregated airspace or, if they need access to controlled airspace, they usually have to obtain an ad hoc 'Exemption' from their local Aviation Authority. At the moment, rules vary from one country to another, an incoherence which makes things more difficult for manufacturers and operators alike: hence the slow rate of progress towards a unified framework across the European Union.

Airframes with a mass of more than 150 kilos are required to obtain airworthiness certification at a European level, from EASA – the European Aviation Safety Agency.

Meanwhile, the UK's Civil Aviation Authority (the CAA) has embarked upon the formulation of a comprehensive set of rules, based – at the small end of the scale – on those governing radio-controlled, model aeroplanes. For larger UAVs, existing regulations covering manned aircraft are being adapted where appropriate, in order to avoid 'reinventing the wheel'.

The CAA recently published a much-awaited third update of the landmark document, CAP 722, and several European counties have expressed an interest in co-ordinating on this basis.

On the military side, the French (the DGA) have also developed USAR (UAV Systems Airworthiness Requirements) for fixed-wing UAVs, which has been adopted as the basis of NATO's STANAG 4671.

All this co-operation is good news, but agreement is required, and EUROCONTROL, the body responsible for co-ordinating UAV integration (both civil and military) has 38 members. It has no statutory authority to impose rules. Reaching a European consensus is taking time. In June this year the European Defence Agency (the EDA) outlined its vision of future

UAV use when it stated that ‘UAVs should routinely be flying in European controlled airspace by 2015’. Although this already represents a slippage from the previously-mooted date of 2012 it is still regarded by most as a highly ambitious target, and those involved in developing the essential systems and legislation are talking about a date nearer the end of the next decade. However, airspace is unlikely to open up to UAVs with a single ‘Big Bang’; the reality is that a phased approach will indeed see certain UAV types certified to fly by the proposed date in certain types of airspace. In this context, continued advocacy from both Industry and Government are needed to make UAV flight routine.

The development of a regulatory framework is being co-ordinated on behalf of EUROCONTROL by EUROCAE – the European Organisation for Civil Aviation Equipment, whose specialised Working Group WG-73 is collaborating with a number of other international participants from industry and the Armed Forces, as well as relevant academic and government bodies.

Progress has been slower than expected, with many skilled personnel working on a voluntary basis without a consistent funding mechanism in place.

Unfortunately, even if legislation and airworthiness certification criteria were in place, there are significant further obstacles to short-term progress. Principal among these is the equally intractable issue of radio frequency allocation. Europe’s airwaves are as crowded as its skies and, like them, are a finite resource. Currently, there are no particular areas of the RF spectrum allocated exclusively to UAV operations, which has already caused significant problems in the military use of UAVs. As with airspace Exemptions, access to suitable areas of the frequency spectrum is granted, according to availability, by the local, national authority on an ad hoc basis.

The assignment of appropriate slices of the spectrum, for UAV command, control and datalinks, will be an agenda item at the next International Telecommunications Union conference, but this won’t be until 2011. Meanwhile the EDA has initiated a project to identify suitable areas of the RF spectrum for use by UAS in Europe as a priority, and the European Space Agency (ESA) is examining the potential rise in demand for satellite communications anticipated as a result of a growing future UAS market.

In parallel with the work being done by legislators to introduce functional airworthiness certification standards and flight rules, industry engineers are seeking to develop a light, low-power, cost efficient and effective Sense and Avoid system. This technology is vital for preventing mid-air collisions by ensuring automatic 'de-confliction' of UAVs flying in non-segregated airspace. It means Air Traffic Control would not have to maintain constant supervision in order to guarantee safe separation between an unmanned aircraft and other airspace users.

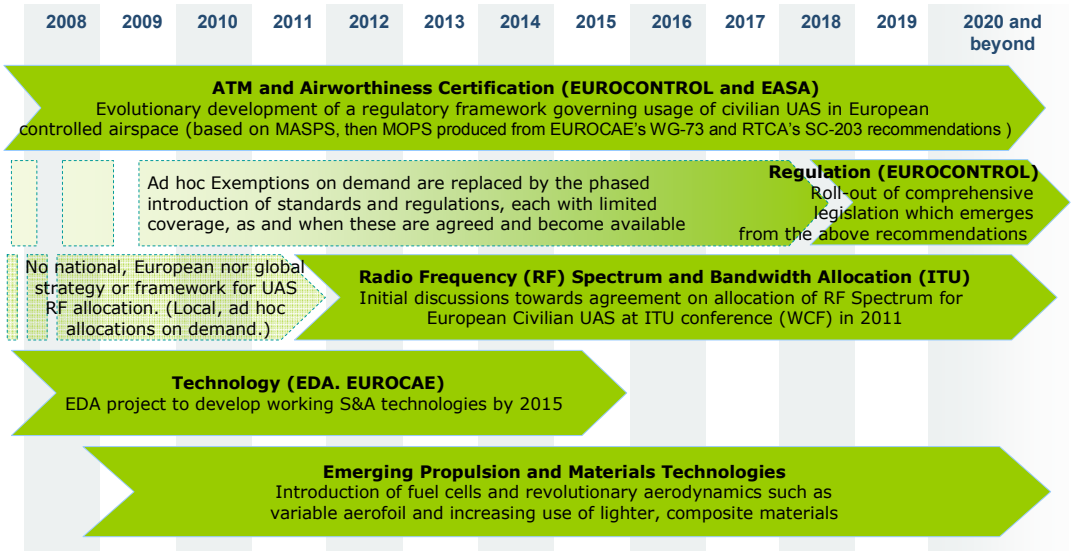
Many of the technical elements needed for such a system already exist. It is the integration of these components into a fully-functional and commercially viable device – within severe space and weight restrictions – that is the challenge. To this end the EDA is supporting the MIDCAS (MIDair Collision Avoidance System) programme. The programme's agenda is "to solve the critical sense and avoid issue and … enable the operation of UAVs in non-segregated airspace"[1]. Its challenge is to come up with workable solutions by 2015.

One further issue of note is that of legal liabilities and insurance for UAVs. For military or State-owned UAVs insurance is not a relevant issue, but for commercial organisations to invest in procurement of UAVs without undue financial risk, access to insurance is a key enabling factor for the market to grow. Within European member states the rules vary and insurance is not yet a statutory requirement everywhere. Nevertheless, present European legislation already requires all UAVs weighing more than 20 kilos to have adequate insurance cover.

However, as yet the insurance industry itself has yet to accommodate or quantify UAVs as a routine risk proposition. As civil and commercial UAVs catch on, insurance will be one area that will present significant opportunities in direct proportion to the market's growth.

The timeline below highlights some of the major issues, stakeholders and expected resolution timeframe for the Civilian UAV market.

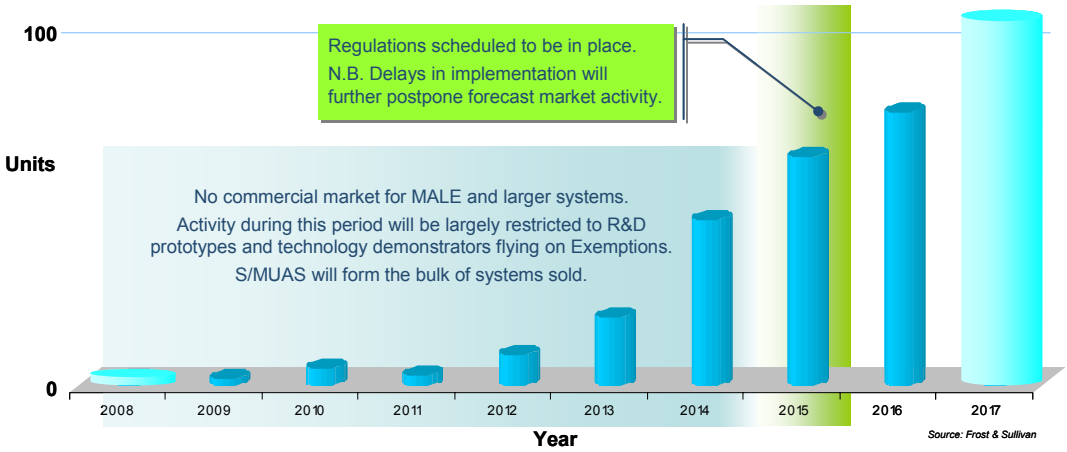
[1] "MIDCAS and EDA Proposed Strategic Objectives 2012", Tomas Eriksson and Régis Brigaud. May 2008



Principal factors governing the evolution of the European civilian UAS market
The above timeline is designed to provide a rough guide to when the principal elements will begin to achieve maturity.

Market Forecast

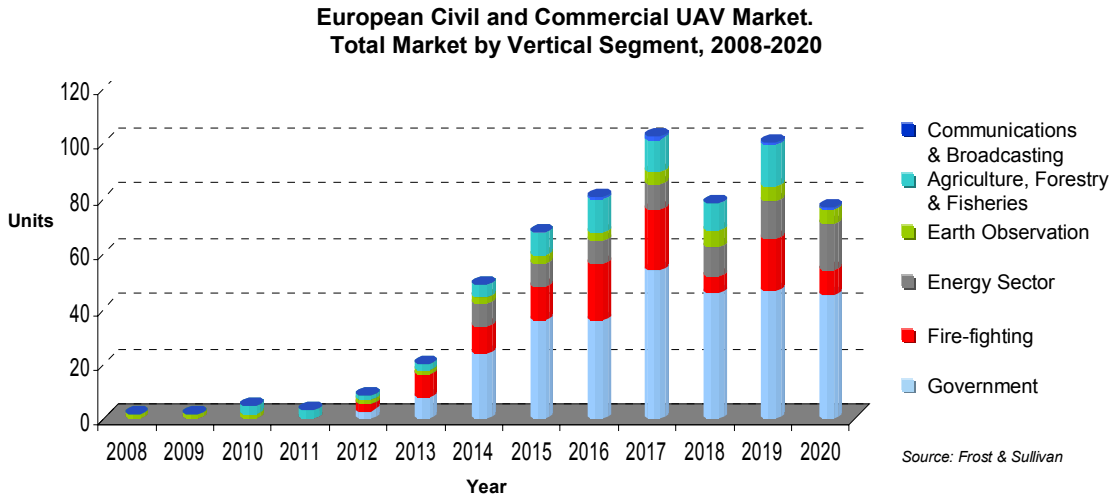
The European civil UAV market is currently almost non-existent in Europe, but over the next ten years sales are expected to increase significantly. Over the next five years ad-hoc experiments will continue, with government agencies and fire-fighting expected to be early adopters – procurement is likely to be related to particular events such as the 2012 Olympics or extreme forest fires – although it is probable that early experiments will not involve procurement of new UAVs, but rather secondment of military systems, such as has been the case in Belgium for maritime patrol reconnaissance.



In the short-term, it is likely that the majority of systems used will be small or mini-UAV systems as these will prove easier to use in within the present air safety regulatory framework. It is also true that procurement of these systems

will be made easier by the lower investment needed, the less sophisticated payload requirements (when compared to military) and the lower training burden. By the middle of the next decade, European government use of UAS is expected to grow consistently and kick-start use of UAS in non-military applications.

Only in the long-term will UAS be used for more ambitious applications such as communications and broadcasting relays.



Conclusion

In the long-term, the civil and commercial UAS market has the potential to grow larger than its military counterpart. However, it will take a considerable amount of time for experience and successful use of UAS in military and a wide range of non-military applications to diffuse across a dispersed European and overseas customer base. The litmus test for the future of the market is relatively simple however: UAS must show that they are more cost effective than current solutions, more effective at completing specific tasks, and they should prove at least as safe as presently available systems. Finally, they should be able to offer new capabilities that currently do not exist. If these factors are in place, issues such as social acceptance and other cultural factors are unlikely to have a major negative impact on the uptake of UAS.

1.2. Economic factors

European defence budgets are expected to grow moderately over the next ten years, particularly in contrast to a potential stabilisation and reduction in US

defence spending. Consequently, Europe is likely to remain a key market for domestic and external suppliers for the foreseeable future.

However, expensive operations and ongoing procurements of costly weapon systems have limited the investment capacity of European governments to support the development of sophisticated UAV systems. Private sector finance has also come under severe pressure in 2008 as the 'credit crunch' bites. Seismic shocks within the global banking system and continuing volatility in the financial markets are likely to breed caution and the potential return of a more conservative approach to investment. This prevailing climate, coupled with the predicted economic downturn will, in the short to medium term, constrain the availability of capital for investment in ventures involving untested – and therefore potentially risky – technology.

As a result, UAS manufacturers have often had to incur significant costs themselves in developing systems for both the military and civilian markets.

Furthermore, forecast growth in individual countries is expected to remain static in markets such as Germany and Spain, which could affect procurement power for UAS when the trend is typically for defence systems to become more complex, and more expensive.

In addition, inflation in commodity prices (including food, energy and raw materials) is likely to have an impact on the wider economic well-being of European countries that are reliant on imports and trade for their economic well-being. Any impact on the overall health of the economy will have an impact on defence spending, which tends to be linked to GDP.

1.3. Political factors

Procurement of defence systems is inherently linked to political considerations, amongst which one must include factors such as multi-national procurement programmes, sustaining economic development and the domestic support of sovereign defence manufacturing expertise.

The growing sophistication of defence systems, increasing costs of procurement have ensured that MoD's have looked to multi-national programmes to provide key capabilities, in the hope that higher volume procurements can lower costs. It is also true that the desired expertise is so

wide-ranging that few, if any, companies possess all the specialist knowledge to fully develop certain modern defence systems. These dynamics are likely to percolate into the UAS space.

Furthermore, environmental concerns have become an important driver in the development and potential procurement of UAVs as they begin to replace many manned platforms. Reduced fuel consumption and the increasing use of innovative alternative energy and power plants have the potential to render UAVs more environmentally friendly than traditional platforms. They are also able to operate safely in environments otherwise inaccessible or too risky to human aircrew, such as a toxic gas cloud following a chemical or nuclear incident, or in extreme weather conditions when monitoring tropical storms and other natural phenomena.

Economic development and sustaining employment in the defence manufacturing base is a key concern when awarding military contracts. UAS, both military and commercial, offer the potential to advance economic development and compensate for potential job losses in a highly cyclic aviation market.

UAS are particularly important in a context where:

- European countries have a major skills base in military aviation that is only supported in the short-term with projects
- Current procurements of Eurofighter, Rafale, and Gripen are expected to be in service for a considerable length of time
- European countries need to ensure they retain the skills and expertise to equip themselves with replacement systems in the long-term, with sovereign control over the systems and support.

Investment in the development of UAS, and centre's of excellence to support their use, are seen as an important element in sustaining sovereign manufacturing and developing the experience that will be needed in the future. The nEUROn UCAV development is particularly representative of an attempt to maintain industrial skills in critical technology areas and systems integration, as well as utilising multi-national co-operation to lower investment and risk.

The UK's Parc Aberporth UAV Centre is a good case study example of how investment in UAS can successfully aid local economic development:

> The Parc Aberporth Centre consists of a Technology Park, West Wales Airport and West Wales UAV Centre (WWUAVC) that contribute to the establishment of a facility that is capable of R&D as well as and Test and Evaluation. The partnership between the Welsh Assembly Government, West Wales Airport and WWUAVC represents
>
> the future vision of sustained economic development driven by the private sector in Wales. The Welsh Assembly Government is responsible for the Technology Park, which is occupied by private companies such as Selex; West Wales Airport is privately run, whilst the WWUAVC is operated between QinetiQ (who also run MOD Aberporth and Cardigan Bay) and West Wales Airport. Since being purchased by the Welsh Development Agency in 2002, the Parc Aberporth site has rapidly transformed itself into a key location for UAS development, testing and certification.
>
> One of the many core advantages the Welsh Assembly Government has delivered to the UAS industry is its ability to build strong alliances between Public Sector stakeholders (such as CAA) and UAS manufacturers who may be competitors in other contexts. These partnerships have proved instrumental in establishing the ability to fly UAS in UK airspace, setting industry and MoD requirements for Parc Aberporth and in attracting industry members to the Technology Park. These partnerships have shown they can be successful in balancing the interests of diverse participants whose goals are very different. Whilst the Welsh Assembly Government has demonstrated a strong focus on long-term economic development, UAS developers have a different goal, yet one that is mutually beneficial to the goal of the Welsh Assembly Government.
>
> It is not incidental that the region in Wales was at risk of job losses due to a concentration of aerospace business in the area. Whilst the facility is presently under-utilised, it is expected to expand, particularly as civil UAV use increases in the future.

1.4. Technological factors

There are a number of critical technology areas in the development of UAS in both the military and civilian sphere, including sense and avoid (S&A), secure datalinks, payloads and systems integration expertise, and the exploration of novel aerodynamic and propulsion solutions. The development of an airworthy platform is one element that is generally considered to be less challenging for major European companies who have tended to focus on other aspects of the UAS.

Nevertheless, numerous industry, academic research departments and other entities (NATO, EDA, for example) are busy looking at innovative ways of approaching UAS-related technologies and of finding applications for their use. Such work ranges from aerodynamics and airframe through payloads and propulsion systems to software and C2 systems design. QinetiQ's *Zephyr* VHALE demonstrator UAV was selected by DARPA (the Pentagon's Defense Advanced Research Projects Agency) as the platform for developing its 'Vulture' project. Zephyr is an ultra light-weight solar/battery-powered hybrid aircraft with a 16 metre wingspan capable of flying above 50,000 feet. In September 2008 Zephyr stayed aloft for more than three days, unofficially beating the previous flight endurance record-holder, Northrop Grumman's *Global Hawk*. The Vulture project envisages a UAV eventually remaining on station for months at a time, as both an observation/surveillance and communications relay platform.

Zephyr began as a joint QinetiQ/MOD-financed project. Government as well as private-sector funding has played an important, though too-often muted role, supporting specialist research as well as more general UAV development. The UK's MOD for example launched in 2006 its Grand Challenge designed to encourage participants of all types and sizes to 'create a system [not necessarily airborne] with a high degree of autonomy that can detect, identify, locate and report a comprehensive range of military threats in an urban environment'. The successful solutions are rapidly to be developed for use by the British Armed Forces.

France's ONERA (Office National d'Études et de Recherches Aérospatiales) has also supported a competition to produce a mini-UAV which mimics nature,

using flapping wings in order to permit the device to hover as well as being capable of directional flight. The private sector as well is working on a range of projects in partnership with academic and other research institutions.

Meanwhile, industry is continuing its quest for a light, low-power, cost efficient and effective S&A system. This technology is vital for preventing mid-air collisions by ensuring automatic 'deconfliction' of UAVs flying in integrated airspace. The design of a reliable system which would allow UAVs to operate from aerodromes and airports also used by manned aircraft is also essential. At the moment, ATC, including ground movements such as taxying, is mostly carried out using voice-to-voice communications unintelligible to a totally unmanned system. The current arrangement will ensure that a UAV pilot, at a remote location on the ground, remains in the loop until methods can be found to increase the level of autonomous operation. Only at this stage will UAVs become truly 'unmanned'.

The existence of such mechanisms – in the air and on the ground – would considerably reduce workload on ATC/ATM systems while ensuring the desired level of safety. It has been pointed out that no new technologies are required to build such apparatus, though existing technologies need to be integrated effectively, miniaturised and adapted to provide a robust and reliable commercially-viable device.

However, one of the overriding issues affecting the development of this technology is in fact one of standards; to date, there are no specifications to act as a goal or benchmark for the performance of sense and avoid systems. Only once these specifications are established can a full assessment take place as to the readiness of the needed technology in this area. Unfortunately, a quid pro quo has developed, with engineers demanding standards from legislators in order to build a system that will meet requirements, while legislators insist that they need to have an understanding of current technical capabilities in order to work out a coherent set of standards.

NATO's STANAGs are providing a useful basis from which interested European, as well as North American parties can work to develop products as well as standards. STANAG 4586, for example, has already been used as the framework for producing interoperable and scalable ground control station designs, and may help to encourage the introduction of a more universally

accepted UAV control interface, such as that which quickly emerged for wheeled vehicles at the beginning of the 20th Century: steering wheel, foot pedals and instrument dashboard. STANAGS are also furnishing a valuable initial basic framework in other areas, such as datalinks (4660), training (4671) and airworthiness standards (4671) that can often be adapted and developed for the civilian sector as well.

Finally, whilst European companies do rightfully enjoy a strong track-record in datalinks, communications technology and in payloads, there is room for improvement in the field of UAS systems integration, and this is one important domain of expertise where US companies are considered to have a significant lead.

2. Major UAV producers with a European presence, their worldwide position today and their current and future market potential in the civil and military sector

European UAS producers have made significant progress in the development of critical technologies and in the systems integration expertise required to field mature and globally competitive UAS systems. However, when evaluated against the track record of Israeli and US manufacturers it is clear that European UAS producers have significant work to do to increase competitiveness in the global market. Furthermore, significant investment and incentives are needed from European governments to encourage and support the development of the European market and industrial capability.

It is worth noting that the fragmentation of the European market into small national markets with favoured suppliers has inhibited innovation and weakened the business case for European companies to invest and fully commit to the development of UAV systems. This is particularly apparent when it comes to the civilian sector. With the failure of the *EuroMALE* programme, there have been few European multi-national investments in UAS procurement. Instead, multiple smaller national programmes have been the most popular means of procurement.

Despite having a globally competitive and highly-skilled Aerospace & Defence manufacturing base, few major European companies have fully developed a UAV system without utilising Israeli platforms or US technology. There are

myriad reasons for this, many driven by the initial slow development of demand in Europe followed by a period of rapid acquisition that has favoured those companies in Israel and the USA with existing solutions.

Early adoption of UAVs by the USA and Israel has enabled companies such as Northrop Grumman, Boeing, Lockheed Martin, AAI, Aerovironment, General Atomics, IAI, Elbit and others to compete in a viable domestic market for a significant period of time. Large-scale acquisition of UAV systems in these markets provided incentive for development and maturation of products that has handed a key advantage to these companies in a market where end-users look to flight-hours as a key indicator.

On the other hand, early European experiences with immature UAV designs were less successful and had an impact in slowing down up-take of the UAS, restraining the emergence of the market. A notable example of this is the case of Denmark, which sold its UAV systems to Canada and is yet to replace them with an equivalent system.

Table showing Flight Hours Maturity

Country of Origin	UAV System	UAV Flight Hours (latest declared milestone)	Price Per System (approx.)
USA	Global Hawk	20, 000	III
USA	Predator	300, 000	II
Israel	Hermes 450	65, 000	II
USA	Shadow 200	300, 000	II
USA	ScanEagle	60, 000	I
USA	Raven RQ-11B	150, 000	I
Israel	B-Hunter	50,000	II
Israel	Aerostar	40, 000	I

Pricing Categories

Category I	< $1 million
Category II	$1 million - $10 million
Category III	$10 - $100 million+

European efforts to transform military capabilities have had to occur in the context of expensive and long-term acquisitions, and ongoing operations with constrained budgets, with the following results:

1. MoDs have often encouraged industry to shift towards utilising Commercial-Off-The-Shelf (COTS) technology;
2. Urgent Operational Requirements (UOR) from Afghanistan, and in some cases Iraq, have shortened acquisition cycles that favour companies with existing mature solutions;
3. European Primes have sought partnerships with international suppliers, to speed up delivery of mature capability and to reduce investment costs and cost to the customer.

An examination of European UAV industry track-record in developing and exporting UAV systems is symptomatic of the immature status of the European UAV market. This is not to say that European industry does not have the ability to develop sophisticated UAV systems, which it obviously does, but that the prevailing marketing conditions have not been in place to warrant such development. Equivalent development took a significant period of time outside Europe (Global Hawk took four years to reach first flight stage), but the market has ensured European companies have taken up this challenge later.

Table Outlining Activities of Major European UAV Suppliers

Despite some notable achievements in delivering complete UAV systems to first adopters (such as the BAE Systems *Phoenix* and SAGEM's *SPERWER*), European UAV manufacturers have struggled to convert these success stories into a position as pre-eminent suppliers within the European market, let alone on a global scale. Where European companies have sold outside the region, this has been the result of US export restrictions such as MTCR or Israeli inability to access the market for political reasons.

The following table illustrates the presence in the military market of the major global UAV manufacturers, and their principal focus by platform class. The civilian and commercial market is as yet still at too early a stage to provide a meaningful picture of its true potential.

UAV Manufacturers in the European Military Market

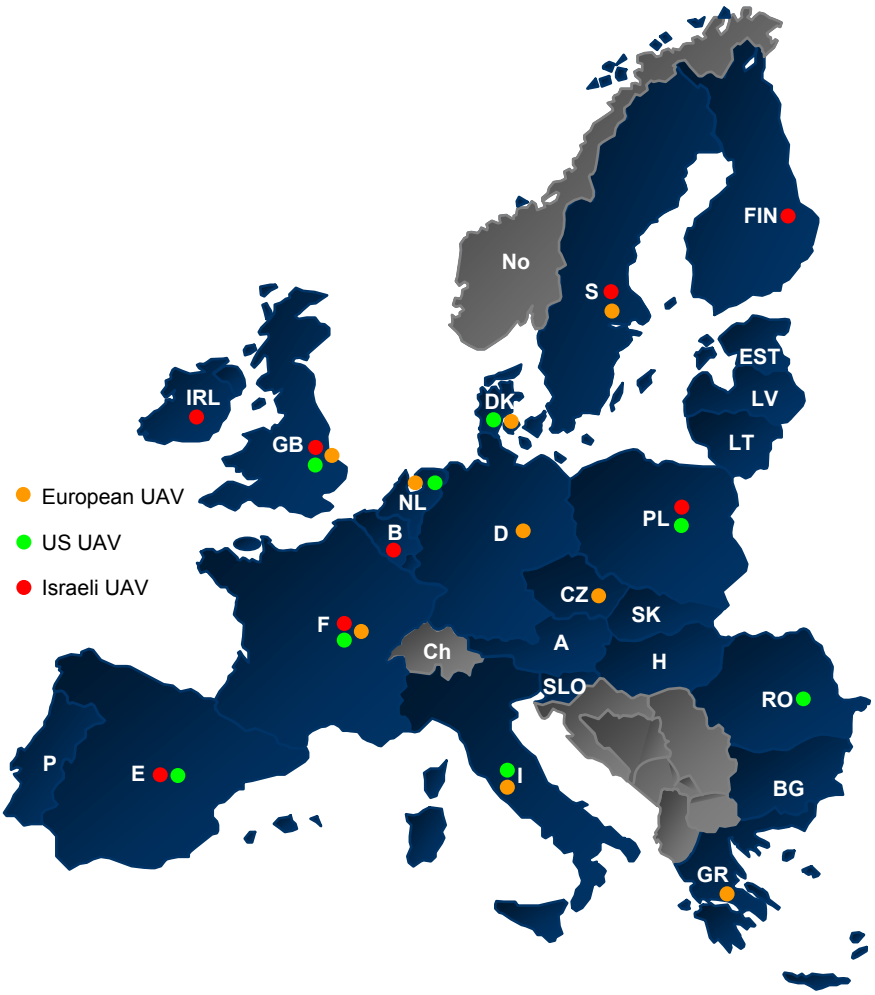
Company	Mini-UAV	TUAV	HALE	MALE	VTOL	UCAV
AAI	Aerosonde				Partner- Honeywell	
Aeronautics						
Aerovironment						
BAE Systems						
Dassault		Partner - Thales				
EADS				Partner - IAI		
Elbit						
EMT						
Finmeccanica						
General Atomics						
Honeywell						
IAI						
Northrop Grumman		Partner - IAI				
Patria						
QinetiQ						
Rheinmetall						
RUAG						
SAAB						
SAGEM						
Schiebel						
Sonaca						
Thales	Partner - Elbit	Partner - Elbit			Partner-Boeing	

Source: Frost & Sullivan

Key

	Sales Outside of Europe
	Sales inside of Europe
	Ready for Market
	Partnership
	Outsourced
	Experimental
	No Major Efforts

Military UAV Procurement in Europe, by Nationality of Supplier



Source: Frost & Sullivan

An examination of UAV procurement in Europe gives a strong impression of the successful penetration of the market by US and Israeli companies. Germany stands out as one of the only major UAV users which has made serious investments in UAVs exclusively with local industry (note, procurement of HALE and MALE UAVs will change this trend). In the EU accession states only limited procurement has taken place although there have been some domestic experiments.

Unlike in Germany, many other major UAV users have opted to procure systems from Israeli manufacturers acting in partnership with a European prime, or directly from US suppliers. In most instances, this is a result of urgent requirements where quick and timely delivery is important and where development of a new, untried platform would take too long. Partnerships with

Israeli or US UAV manufacturers have provided operational advantages in this regard.

2.1. AAI

Company Overview

AAI Corporation was acquired by Textron Systems Corporation in 2007, and is best known for its Shadow range of UAVs. The company has been active internationally and expanded its global footprint through its acquisition of Aerosonde in Australia.

Market Success

AAI's *Shadow 200* (designated RQ-7A/B by the US Department of Defense (DoD)) achieved initial operating capability with the US Army in 2003 and has since had success with the US Marine Corps. In May 2008, the platform reached a milestone of 300,000 flight hours. The DoD intends to employ over 300 units of the Shadow family, making the platform the dominant system in the tactical UAV segment globally. AAI has also sold its system to Romania and has won competitive projects to train US soldiers in how to use mini-UAVs, in particular Aerovironment's *Raven*.

Partnerships

AAI partnered with Honeywell in the development of a micro UAV using ducted fan technology.

Civilian Market Activities

AAI has a keen focus on the civil UAV market in the future.

2.2. Aeronautics

Company Overview

Israeli company Aeronautics Defense Systems has become one of the most successful companies in winning UAV contracts in the international market in recent years. The company has diversified to offer significant expertise in the

wider C4ISTAR domain and has pioneered business models through innovative contracting. The company differentiates itself through having the full range of UAV technologies and capabilities it needs in-house. The company is known for breaking the 18,000 ft altitude record with its *Orbiter* UAV.

Market Success

The company has had success with the Israel Defence Forces, the US Navy, Nigeria and Angola, among other undisclosed clients, with its *Aerostar* platform. The *Orbiter* mini-UAV is currently being operated by Polish forces in Afghanistan and has also been sold to the Israeli Defence Forces and Irish Defence Forces, among other undisclosed international clients.

Partnerships

Aeronautics has a number of partnerships:

- General Dynamics OTS
- Motorola
- Controp

Aeronautics has also been active in acquisitions to expand the range of its capabilities through the following companies:

- Knowledge Control Systems
- Zanzottera Engines
- Cielo
- Commtact

Civilian Market Activities

Aeronautics offers a range of UAVs for civilian market applications. The company has offered a service-based model for their use and has done a remarkable amount in this sector, including:

- Patrolling off-shore oil platforms since 2003
- Wildfire inspection (with *Aerostar* and manned platforms)
- *Aerostar* trialled with Israeli Traffic Police
- TV Broadcast relay for Israel's Channel 2

In many respects, the maturity of the Israeli market and the regulatory environment has enabled Israeli companies to gain very significant experience in the commercial UAV market.

2.3. Aerovironment

Company Overview

Aerovironment is a leading company in Small/ Mini-UAV developments and efficient electrical energy technologies. With a considerable portfolio the company has evolved into a UAV developer that is the main provider of Mini-UAVs to the US Military and also to a number of European customers. The company's product portfolio includes *Raven*, *Dragon Eye*, *Puma*, *Wasp III*, *Swift*, and developments including the *Pathfinder* and *Global Observer* very long endurance (VHALE) platforms.

Market Success

The *Raven* mini-UAV is massively used by the US Armed Forces and is also operated by Denmark, Italy, Spain and the UK. Other nations such as the Netherlands also have a large order of Raven systems. Over 8,000 units have been produced and delivered to customers – mainly in the US – making the *Raven* one of the most widely used UAVs in the market.

Partnerships

Aerovironment has developed a number of partnerships to advance its research, including with NASA.

Civilian Market activities

Aerovironment's mini-UAVs have already been deployed in fire fighting and other natural disaster missions, and trials have been carried out using its VHALE *Global Observer* in broadcasting relay roles for Japanese HDTV and 3G mobile telephony networks. R&D investment is focussed on miniaturisation of payloads, and the development of innovative power and propulsion systems, which goes in line with the initial process expected in the civilian UAV market.

2.4. BAE Systems

Company Overview

BAE Systems is one of the largest trans-Atlantic Aerospace and Defence companies, with 2007 sales of £15 billion (€19 billion). BAE Systems' declared strategy is to focus on its core markets of UK, the USA, Australia, Saudi Arabia, South Africa and Sweden. The European Union defence market is of comparably little importance to the company.

Where UAVs are concerned, BAE Systems has made some significant investments in developing technology demonstrators, and within the UK the company is considered the national-champion for development of fixed-wing attack aircraft and a leading partner for UAV and UCAV development. BAE Systems' core developments are taking place around four developmental programmes; *Taranis, CORAX, HERTI* and *Mantis*. There are parallel developments in BAE Systems' USA division which has developed UAVs including the *Skyeye*, and fan wing concepts for DARPA, among others.

UAV Market Success

BAE Systems is one of the few European companies to have developed and sold a considerable number of UAVs, namely the *Phoenix,* which was commissioned in the mid 1980s and used as part of the NATO operations in Kosovo. Much of BAE Systems' revenues in the UAV sector since then have been through funded R&D in the UK, where it has received a £124 million contract to develop the Taranis UCAV from 2007-2010. Until this contract, BAE Systems had largely been developing systems and technology at its own expense in order to maintain its expertise and develop core technologies in readiness for emerging contracts in the UK and elsewhere. The *Mantis* can be seen as the fruit of these efforts.

With regard to operational use of UAVs, BAE Systems can claim to be one of the most experienced in Europe. *Phoenix* was used extensively in Kosovo in 1999 and in Iraq from 2003. BAE Systems' *HERTI* UAV has been used as a MALE platform in Afghanistan since 2006 as part of the Royal Air Force's Project Morrigan, in which the MOD receives access to a UAV at no cost and

BAE Systems benefits from gaining greater experience with UAVs and exposure within the UK MOD.

As a result of its extensive experience with UAVs, BAE Systems is playing a leading role alongside Thales UK and others in the UK MOD's UAV capability investigation.

Partnerships

BAE Systems has been active in developing partnerships within the UK industrial base to complement its expertise in UAV systems.

The *Kestrel* UAV was co-developed with Cranfield University, which became the first jet powered-UAV to fly in UK airspace approved by the Commercial Aviation Authority in March 2003.

BAE Systems' main industrial partnership has been part of the *Taranis* project, in which Rolls-Royce, QinetiQ and Smiths Aerospace (now GE Aerospace) are collaborating under BAE Systems' leadership.

Civilian Market activities

BAE Systems has a significant interest in the Civilian UAV market, as the company's development work and initiatives have shown. In particular, the *Kestrel*'s flight in UK airspace is significant. Like many UAV manufacturers (both inside and outside of Europe), BAE Systems seems to be well aware of a need for advocacy of UAVs in civil or commercial applications and has formed significant partnerships to make this happen.

It is public knowledge that BAE Systems has shown interest in employing its Herti system for government security tasks in the UK. The company has formed the *South Coast Partnership* with local police forces in Kent and Sussex to develop UAVs as part of their policing arsenals. Furthermore, BAE Systems is promoting the use of Herti to provide security at the 2012 Olympics.

BAE Systems is also a member of the ASTRAEA programme. ASTRAEA is a UK-based group bringing together industry, government, academia and regional development agencies in order to promote and facilitate the early integration of UAS into UK airspace.

2.5. Dassault Aviation

Company Overview

Dassault Aviation is at the forefront of aviation in Europe and a major player in the French military aviation market. With regard to UAVs, Dassault Aviation has adopted an incremental approach for R&D, rather than investing in concepts that are yet to be proven. Whilst it has employed a number of partnerships in its development of test and demonstration platforms, Dassault Aviation's sales footprint in the UAV market is limited.

To understand Dassault Aviation's UAV development, it is essential to understand that the company is approaching the market with an eye on the long-term strategic interests of the company. Dassault Aviation has identified the wide range of tasks UAVs will conduct on the future battlefield, and is focussing research on developing survivable (i.e. stealth) UAVs and UCAV systems.

UAV Market Success

Dassault Aviation has focussed its investment on the development of a UCAV rather than in targeting upcoming UAV procurements. The company has won significant funding for these activities from the French DGA.

Partnerships

Development of partnerships has been key to Dassault Aviation's activities in the UAV market. Dassault Aviation has concentrated its partnerships on working with European aerospace companies, rather than with Israeli or US suppliers.

In 2003, Dassault Aviation and Sagem developed a partnership jointly to develop and market a 'next-generation' of TUAVs to compete for the France Army project for TUAV MCMM, which has since been cancelled.

Dassault Aviation also leads the European nEUROn UCAV project, based on a contract it won from the DGA in 2006. This programme builds on its R&D into UCAV as part of experience in the LOGIDUC programme and aims to develop a UCAV technology demonstrator ready for first flight in 2011. In order to share the burden for its funding, and to help maintain European-wide

aviation expertise, a number of partners have joined the programme, including SAAB (Sweden), Alenia (Italy), Helenic Aerospace Industry (Greece), EADS (Spain/France), RUAG (Switzerland) and Thales (France).
Dassault Aviation has recently partnered with IAI, Indra and Thales to issue an unsolicited offer to the French and Spanish governments for a theatre-wide MALE UAV aimed at competing with EADS Advanced UAV.
The company is also co-operating with Thales to market Watchkeeper outside the UK.

Civilian Market activities

Dassault Aviation is largely focussed on the military market, as evidenced by its focus on UCAV and stealth technologies.

2.6. EADS

Company Overview

EADS is a leading European player offering a range of UAVs from small TUAV to HALE platforms, both fixed and rotary -winged. Like other foremost UAV participants, EADS realises that, at this stage, the only path to success in this market is to bring the different links of the value chain under the same roof. In order to achieve this, partnerships with other companies such as IAI and Northrop Grumman have been part of EADS' business strategy towards the European UAV market.
Considerable investments in R&D have also characterised the group's effort to design UAVs; technological achievements have been seen in the past three years, although EADS has not reached the market expected. In this context, the group is currently diverting more effort towards the civilian market, which the company believes will provide great opportunities in the near-future.

UAV Market Success

EADS' presence in Europe is highly significant. The group has succeeded in providing the CL-289 jet drone to the German and French armies since 1992, and its deployment for peacekeeping operations in Bosnia and Kosovo has made it a precious asset for future UAV development and battlefield concepts crystallisation.

As it stands, EADS is the only company in Europe that has the capabilities to introduce a HALE UAV proven solution into the European market. EADS / Northrop Grumman emphasise that their joint effort, the Euro Hawk, is aimed at being a regional system. They also note that several European countries, including Sweden, Spain, Italy, Norway and France, have already expressed an interest in the Euro Hawk.

Partnerships

The CL-289 was developed as a tri-national project between Canada, France and Germany. Bombardier Inc. and the Canadair Group of Canada were the system leaders and EADS Dornier GmbH the prime contractor. At the beginning of 2001, EADS Dornier GmbH was awarded a contract by NATO for the upgrade of 160 French and German army CL-289 UAVs.

Another partnership, this time with IAI, gave EADS the capability to supply the French Army with the Eagle I and II TUAVS. The Israeli-based platform represented an opportunity for EADS to master the UAV technology in a different spectrum.

Finally, EADS' joint venture with Northrop Grumman, started in 2000. The companies decided to combine Northrop's Global Hawk's (RQ-4A) airframe capabilities with an EADS tailored payload. Looking back at 2003, 15th October was probably the most important day in the European UAV community calendar. On that day, after flying from Edwards Air Force Base in California, the Euro Hawk landed at the German Navy's Nordholz Air Base. The aim of this test flight was both to demonstrate the Euro Hawk Electronic Intelligence (ELINT) capability and, probably more importantly, to introduce flight operations by a HALE UAV into European-controlled civil airspace.

These ventures allow EADS to quickly enter the world of MALE and HALE UAVs. The Eagle II, in particular, will allow them to be competitive both in the relevant military categories and, in the long term, in civil and commercial markets.

Civilian Market Activities

EADS has demonstrated interest in the civilian market and in-house technology, such as the Eagle II, is to be use as basis for new developments involving civil applications for UAVs.

2.7. Elbit

Company Overview

Elbit is an Israeli defence electronics company that achieved revenues of US$1.9 billion (€1.3 billion) in 2007. The company's product range covers a whole range of segments including Land, Naval, Air, Training and Simulation, C4ISTAR, EW and UAVs. The company has had significant success acting as a Tier 2 systems provider in the European market, and has made significant inroads into the global UAV market.

UAV Market Success

Internationally, Elbit has shown itself to be one of the most successful UAV providers, with sales to Israel, the UK, Georgia, Sweden, France and a number of undisclosed international customers, including in Europe.

The company is working with Thales UK on the biggest ongoing UAV procurement, the UK's *Watchkeeper* programme, worth over £800 million (€1 billion). The company's *Hermes 450* is currently being used as part of the UK's Urgent Operational Requirements, operated by non-military company personnel.

Partnerships

Elbit has a joint venture with Thales UK, known as U-Tacs. The company has also partnered with IAI in an ongoing effort to supply Turkey with UAV systems. In order to win a mini-UAV contract in Sweden, the company acted as a sub-contractor to SAAB.

Civilian Market Activities

Within Israel, Elbit UAV systems have been certified as fit to fly in civilian airspace.

2.8. EMT

Company Overview

EMT is a UAV systems house located in Germany. Whilst not a major Aerospace and Defence player, the company has had a remarkable amount of success in the UAV space. Due to its relatively small size and excellent engineering skills, the company has been very agile in developing systems ready for the market.

The company's product portfolio is focussed on its mini-UAV systems *Luna* and *Aladin*. Luna is a small tactical rail-launched UAV in use with the German Army, and Aladin is a mini hand-launched UAV in use with German and Dutch forces, and it has been tested by Norway. By the end of 2006, the Luna had conducted more than 2,000 missions.

EMT has also developed a small ducted-fan VTOL UAV called *Fancopter*, ready for market and aimed at fulfilling Germany's requirements for tactical ISR in urban environments. The company is also developing a Micro-UAV called the *MIKADO*, and a high-speed tactical system known as the *X-13*.

EMT's UAVs have been used by Germany's Bundeswehr in Afghanistan, Kosovo and in the Democratic Republic of the Congo (DRC).

UAV Market Success

EMT's main success to date has been in the German market, where it sold 115 Aladin systems in a March 2005, €25 million contract, as well as supplying the Luna since 2000. The Luna was also been sold to the Pakistani Army in 2006 and is used to patrol the country's border areas.

EMT also sold 10 Aladin systems to The Netherlands in 2006 for operations in Afghanistan, a contract in which the company has benefited from the willingness of the German Army to share its experience and help train customers of the system.

Partnerships

EMT has tended to develop its UAV systems in-house, but does out-source elements of the system, such as the Inertial Guidance and GPS navigation systems it bought in from Athena Technologies.

Civilian Market activities

EMT is very much looking at the civil UAV market for its future growth. In November 2006 the owner of EMT, Hartmut Euer, highlighted the importance of this market to the company and the opportunities it presented:

> "There are truly many possibilities. And 'possibilities' is not at all the right word – they are real necessities. For instance: the security of major installations such as power plants, industrial complexes, and military bases. But there are many others as well, such as protection of waterways, national border and energy conduit surveillance: consider oil and gas pipelines and electricity networks. Our drones would be a great help for the monitoring of water pollution and the measurement of local radioactivity after reactor accidents."

The company is well placed to take advantage of any opportunities in the civil market, once the requisite regulations are in place.

2.9. Finmeccanica

Company Overview

Within the umbrella of Finmeccanica Group there are a number of companies looking at the development of UAVs, and the Group has already made UAV sales in Europe and beyond. There are three principal Groups involved in UAV development, with an agreement in place within the company to focus expertise and ensure the Group has a broad product portfolio without product overlap.

Galileo Avionica (part of Selex Galileo, formerly Meteor SpA.) has the responsibility for the *Falco* UAV, the *MIRACH-100* target drone and the *NIBBIO*.

Selex S&AS covers the smaller systems with the *OTUS* and *STRIX* Mini-UAVs and the *ASIO* VTOL.

Alenia Aeronautica is responsible for the larger UAVs, and has the *SKY-X*, *SKY-Y* and *Molynx* UAVs in its portfolio. Itis also responsible for Italy's role in the NeuroN programme. The Molynx has a lethal UAV in parallel development known as the *Blacklynx*, which is undergoing evaluation.

Through its recent acquisition of the US Company DRS Technologies, Finmeccanica has been able to add to its product portfolio the *Neptune* and *Sentry* UAV systems.

UAV Market Success

The Finmeccanica Group has had a considerable degree of success in the UAV market, but has so far not been able to take advantage of its position in the Italian market, which has opted for solutions from the USA in the form of the General Atomics *Predator* and the Aerovironment *Raven* (RQ-11B) mini-UAV.

The Mirach-100, although primarily a target drone, is capable of performing ISTAR missions and has been successful in the market, having sold widely within NATO and to export customers outside Europe.

Finmeccanica has sold its Falco UAV to the Pakistan Air Force, in a contract from 2006.

Partnerships

Finmeccanica has secured some partnerships to develop UAVs, most notably it is a member of the nEUROn UCAV development programme. This involvement is based on Alenia's work with the Integration Technology Vehicle. Concerning smaller systems, Finmeccanica has partnered with several Italian SME's such as Alpi Aviation and UTRI for the supply of its mini-UAV systems.

Other elements of its proprietary UAV systems are outsourced and, like EMT, Finmeccanica uses Athena Technologies guidance systems. The company also outsourced propulsion systems.

Galileo Avionica acted as partner to General Atomics through local assembly of the Italian Air Force's Predator UAVs.

Civilian Market activities

Finmeccanica companies have a keen interest in the civilian UAV market, in particular for their paramilitary and critical national infrastructure protection applications. Selex S&AS in the UK is heavily involved in initiatives located at the Parc Aberporth UAV Centre.

2.10. General Atomics

Company Overview

General Atomics is a leading US company in MALE UAV development. The company's Aeronautical Systems division develops the *Predator* UAV and its variants (*I-GNAT* and *Sky Warrior* series). Having the US Armed Forces as initial customer, General Atomics has now reached global recognition, being considered as a strong candidate to provide MALE UAVs in Europe and elsewhere. The company has been successfully focussing on improving the reliability and effectiveness of the Predator series as platforms, as well as developing specific payloads for their various platforms.

General Atomics acts as prime contractor and has other companies supplying payloads and communication systems: Northrop Grumman provides the synthetic aperture radar; Versatron/Wescam the electro-optical system; Boeing the intelligence work station and mission planning systems; and L3 the satellite communication device.

UAV Market Success

General Atomics has great success in the UAV market. Following the success of its first order in 1994, the US Armed Forces now has an inventory of over 150 Predators (A and B) and uses them extensively in current operations. Capable of carrying guided-bombs, the Predator B – commonly known as the *Reaper* – has been a platform of choice in Afghanistan and Iraq for tactical target spotting and engagement. With over 300,000 hours of successful flight hours, the Predator series is to be considered something of a UAS benchmark. In 2005 the Italian Air Force selected the Predator to be part of its UAV capabilities and its effective deployment record was crucial for the subsequent acquisition of a further two units.

Partnerships

General Atomics partnered with Italian Meteor in order to provide Predator systems to the Italian Air Force. The deal presumed the acquisition of a ready-to-go platform and the production of five units in Italy managed by Meteor.

The direct partnership highlighted General Atomics' perception of the global market where the company sees potential partnership as an opportunity to enter new markets – such as Italy. The established relationship with sub-suppliers – especially with prime contractors such as Northrop Grumman – represents General Atomics' success in the UAV market.

Civilian Market activities

The USA's Department of Homeland Security has a stable of four Predators for carrying out border patrol missions. NASA uses General Atomics' *ALTUS* (a modified Predator) UAV for scientific research. For commercial use, the Predator series was the first to receive the FAA's commercial UAS airworthiness certificate (experimental category only).

2.11. Honeywell

Company Overview

Honeywell is a diverse technology group addressing international markets in aerospace, automotive and transportation, and specialty materials. In the field of UAS, Honeywell is well known as a sub-system provider on major platforms such as the General Atomics Predator; the company also develops technologies such as multi-UAV co-ordination, autonomous navigation, sense-and-avoid and air traffic management of UAVs in commercial airspace.

UAV Market Success

Honeywell has developed a mini-UAV that uses a ducted fan for vertical take-off and landing (VTOL), which it has sold in the US and to the UK. The company has had considerable success as a sub-contractor on various other UAS programmes, most prominently on Predator.

Partnerships

To develop the MAV ducted fan UAV, Honeywell worked with AAI.

Civilian Market activities

Honeywell is a prominent player in the advocacy of the civilian UAS market, and is in the process of developing crucial technologies that will allow this

market to develop, including sense and avoid (S&A). Whilst the US and Canada are Honeywell's primary markets, the company is actively engaged with the European market.

2.12. Israel Aerospace Industries (IAI)

Company Overview

Israel Aerospace Industries is a major global player in the UAV market, and has achieved significant business success in Europe in this sector. The company's total sales were US$2.8 billion (€2 billion) in 2006 and are focussed on growing internationally. Malat division is the business within IAI that is dedicated to the UAV market.

UAV Market Success

IAI has considerable success in the market, supplying France, Belgium, Switzerland, Finland, Turkey, India, the USA, Spain, Australia, Israel and other undisclosed international customers.

Partnerships

IAI's presence in the European market is becoming more pronounced, although its key successful strategy to date has been to partner with major European primes in order to access the market. In the past IAI has partnered with EADS on the *Eagle* and *Hunter*, with Sonaca on *B-Hunter*, with RUAG and Finland on the *Ranger* project. This trend is continuing, with IAI a major element in a partnership with Thales, Dassault Aviation and Indra to supply France and Spain with MALE UAVs.

Civilian Market activities

IAI-Malat has been active in supporting the development of the civilian UAV market in Europe, participating in a number of different working groups such as USICO (UAV Safety Issues for Civil Operations), the Joint Aviation Authorities-EuroControl Taskforce and France's UAV System Airworthiness Requirements (USAR) working group within the DGA. Additionally, IAI Engineering has worked to initiate the European Commission Research

Activities which have led to the launch of projects such as UAVNET and CAPECON.

Within Israel, IAI UAV's are certified to fly in civilian airspace and are used in a wide range of applications.

2.13. Northrop Grumman

Company Overview

Northrop Grumman is among the largest defence companies in the world, with 2007 revenues of US$32 billion (€22.6 billion). In the UAV market, the company is perhaps best known for its *Global Hawk* HALE system, although it has a very wide product portfolio including the *Fire Scout* VTOL, *Hunter*, *X-47B* UCAS and the *M324 Penetrator* UAV.

UAV Market Success

Northrop Grumman is one of the most successful UAV manufacturers, with major sales to the US Air Force and the US Navy. The company is also playing a major role in the delivery of the Euro Hawk UAV to Germany, and has made other sales to countries such as Egypt.

Partnerships

The main partnership within Europe is currently with EADS on the Euro Hawk programme. In the past, the company has partnered with BAE Systems, General Dynamics UK and QinetiQ, among others, to win the UK's *Watchkeeper* programme.

Civilian Market activities

The Global Hawk has been employed by NASA in the United States for scientific research.

2.14. Patria

Company Overview

Patria is owned by the Finnish state and EADS, and along with Insta, is the preferred supplier of the armed forces of Finland. The company has

traditionally been geared towards the domestic market, but has made some significant export successes in the Armoured Combat Vehicles market and is increasingly focussed on expansion into European and global markets.
With reference to UAVs, Patria's product portfolio is limited, but the company does have expertise in a number of relevant areas, including aerostructures and datalinks.

UAV Market Success

Patria has developed a mini-UAV system that is undergoing tests with the Finish Army as part of an ongoing study the military is conducting.

Partnerships

The company operates a number of partnerships with companies active with UAVs, such as AAI, Rheinmetall and Sagem. However these are partnerships operating in other areas.
Recently, Patria signed a co-operation agreement with the Swedish UAV manufacturer CybAero, in which marketing and maintenance competences are shared.

Civilian Market activities

Patria shows a keen interest in the civilian market and examines ways in which it can transfer its defence expertise.

2.15. QinetiQ

Company Overview

QinetiQ is a highly developed technology company that has commercialised British government developed technology, originally known as DERA.
The company's expertise covers a variety of areas, such as Aeronautical engineering, communications, land systems, test and evaluation, autonomy and power systems.

UAV Market Success

QinetiQ's most visible activity in the UAS field has been in the development of the *Zephyr* Very High Altitude Long Endurance (VHALE) solar powered UAV. This system has been selected for development by the US Defence Advanced Research Projects Agency (DARPA) to fulfil its *Vulture* UAV programme, looking to develop an ultra long endurance, high-altitude platform.

Partnerships

QinetiQ is involved in a number of organisations in the UK, such as ASTRAEA and is also involved in *Taranis* with BAE Systems. Other than this, QinetiQ has developed a lasting partnership with Boeing in the UAV field, through work with the Welsh Assembly Government and in the US with DARPA's *Vulture* UAV programme.

Civilian Market activities

QinetiQ's technology skills are of significant importance to ongoing work in the UK in the attempt to integrate UAVs into non-segregated airspace. Its major notable foray into the civilian space has been in work combined with Boeing, the Institute for Grassland and Environmental Research and the Welsh Assembly Government.

2.16. Rheinmetall

Company Overview

Rheinmetall is a growing force in the field of UAVs since its acquisition of STN Atlas Elektronik in 2003. The Rheinmetall group is already the highly regarded supplier of a wide variety of defence systems including munitions, land systems, training and simulation, C3I and UAVs.

Within Europe, Rheinmetall is one of the few companies to have fully developed UAVs in its product portfolio without recourse to Israeli suppliers, and has had sales successes in Germany.

The company's UAV product portfolio includes

- The *KZO* tactical UAV
- *Tares* attack drone (a development from STN Atlas' *Taifun*)
- *Opale* (Optionally Piloted Surveillance and Reconnaissance System)
- European *Eagle Eye* VTOL UAV

- *Carolo P50* mini-UAV

UAV Market Success

STN Atlas had significant success in the 1990s, having won development contracts from the German government for development of the Taifun, as well as the *Brevel* and *Mucke* UAVs. More recently, Rheinmetall sold 60 UAVs to Germany's Bundeswehr in a contract worth €180 million from 2005.

Partnerships

Whilst Rheinmetall has been active in partnering, it is one of the few companies to develop and field complete UAV systems.

Notable partnerships include:

A signed agreement with IAI for the production of loitering munitions to fulfil Bundeswehr requirements. These systems are expected to be integrated with Rheinmetall's KZO platforms. Additionally, Rheinmetall has decided to partner with IAI on marketing the Heron MALE UAS to the German MoD.

In the development of the European Eagle Eye VTOL, Rheinmetall is partnering with Bell Helicopter Textron and SAGEM to modify the platform for European requirements. It is notable that prior to its acquisition by Rheinmetall, STN Atlas signed a Memorandum of Understanding (MOU) with SAGEM in the field of UAVs to develop interoperability between the KZO and Sperwer.

Ahead of the German decision on which MALE platform to adopt, Rheinmetall has partnered with Diehl BGT Defence and General Atomics to bring to market a MALE / HALE system that will be based on the *Predator* platform but with Rheinmetall ground control stations (GCS).

For Rheinmetall's Carolo mini-UAV, the company partnered with the University of Bremen.

2.17. RUAG

Company Overview

Based in Switzerland, RUAG has business units focussing on aviation and space, defence and security, and ammunition and other products. The

company's UAV expertise is centred within its aviation and space business, in which the company has successfully developed some effective technologies such as automatic landing systems, a skid landing system and catapult launchers.

The company positions itself as a partner in the UAV sector, and has partnered with IAI to bring UAVs to market, with some export success.

The company is increasingly focussed on expanding its international presence and has manufacturing facilities in Switzerland, Germany and Sweden. RUAG is interested in developing strategic relationships with its customers in Europe and is positioning its UAV development for this market.

UAV Market Success

RUAG has had success in providing its *Ranger* UAV to the Swiss Air Force and also the Finnish Defence forces. The company has developed a next-generation system known as the *Super Ranger* UAV that will offer performance advantages on the current system; to date no sales have been made.

Partnerships

RUAG partnered with IAI Malat and Oerlikon-Contraves to utilise a mature UAV platform, and added its own technologies. The company competed in the UK's *Watchkeeper* programme with Northrop Grumman, but was unsuccessful in winning the contract.

Civilian Market activities

The RUAG Ranger was cleared to fly in non-segregated airspace and has flown over populated areas of Switzerland in support of civilian tasks such as border control and fire fighting, as well as working with the Swiss police on traffic monitoring duties.

2.18. Saab

Company Overview

SAAB has been extremely active in the development of UAVs and has focussed on a number of technology programmes that it has embarked upon,

both alone as well as in partnership with other European companies. Until recently the company did not manufacture UAVs or have systems available ready for market, but instead acted as a partner and gateway to the Swedish market.

Saab had two advanced UAV demonstration programmes, known as the *SHARC* (Swedish Highly Advanced Research Configuration) and the *FILUR* (Flying Innovative, Low-observable Unmanned Research vehicle). The programmes were launched in the late 1990s and formed the basis of SAAB's participation in the nEUROn UCAV development team.

Within SAAB, there are multiple divisions developing UAVs and unmanned technologies, with SAAB Aerosystems working with Tactical level UAVs and higher, SAAB Underwater Systems has developed an Unmanned Underwater Vehicle and SAAB Aerotech focusses on technical support and systems integration. The companies overall approach is mature and sensible in that it focussed on integration of UAVs into a network-centric approach.

The company is now bringing systems to market, and has developed a rotary VTOL UAV known as *Skeldar* to fulfil tactical UAV requirements.

Independent of this, the company is developing a tactical UAV, aiming for the market in around 2009-2010, building in technology developed from different aerospace programmes such as the *Gripen* multi-role fighter, and from its existing UAV development programmes.

UAV Market Success

SAAB has been a key partner in gaining access to the Swedish market and helped manufacture elements of the *Ugglan* UAV (the Swedish version of *Sperwer*) such as the electrical harnesses and mechanics, and was involved in systems integration, testing and training.

SAAB was also the prime contractor for Sweden's procurement of Elbit's *Skylark* mini-UAV (known as *Falken* in Sweden).

Partnerships

SAAB has a number of partnerships in place in the field of UAV development, and has worked with SAGEM and Elbit in bringing UAVs to the Swedish

Armed Forces. The company also acts as a significant part of the nEUROn consortium.

In 2007, the company signed a letter of intent with Alenia Aeronautica and Dassault Aviation to co-develop a next-generation MALE UAV, with Alenia Aeronautica taking the project leadership role.

Civilian Market activities

The Swedish government is very advanced in thinking about potential applications of UAVs in civilian or commercial activities. SAAB is marketing its VTOL *Skeldar* as a dual use platform equally capable in military and civilian applications.

SAAB has worked with the Swedish Airports and Air Navigation Services, the Swedish Civil Aviation Authority and the Military Aviation Authority to run the Castor demo to experiment and work towards flying UAVs in non-segregated airspace.

2.19. Sagem

Company Overview

Part of the SAFRAN group, SAGEM Défense Sécurité specialises in a number of areas, including information systems, soldier systems, optronics and UAVs among other capabilities.

The company is one of the most successful in Europe in the UAV sector, having developed and sold the *Sperwer* UAV to a number of European customers as well as to Canada.

The company is aggressively expanding its UAV product portfolio through internal development and co-operation with other companies. This has seen Sagem increase its weight in the mini-UAV category with a number of systems ready for market, including the *ODIN* VTOL and the *MERLIN* mini-UAV.

The company has also developed a larger version of its tactical UAV, known as the *Sperwer-B*, which has longer range and a higher payload capacity than the original. Also in the long-range segment, Sagem is developing a system known as *Buzard*.

UAV Market Success

Sagem has made considerable sales of the Sperwer UAV to The Netherlands, Sweden, France, Canada and Denmark.

Partnerships

The company initiated a partnership with General Atomics to potentially provide a MALE UAV to France, based on the Predator, though lack of sales in this area forestalled any broader arrangement.

SAGEM has also worked with Rheinmetall and Bell Helicopter Textron in bringing the Eagle Eye VTOL UAV to the European market.

At the request of the DGA, SAGEM has worked on studies examining the mounting of missiles on its UAVs, and in this regard has worked with Rafael from Israel (*Spike* Missile); this relationship has matured into the wider UAV space and there is some co-operation in the mini-UAV area.

SAGEM has recently acquired the Finnish company Robonics, which specialised in UAV launch systems, as well as owning a massive test range in the North of the country that is suitable for large UAV testing.

Civilian Market activities

Sagem was awarded a 2006 contract worth €750,000 from the European Defence Agency (EDA) to conduct a study into 'sense-and-avoid' (S&A) technology that will help enable UAVs to fly in non-segregated airspace.

2.20. Schiebel

Company Overview

Schiebel defines itself as an innovation company, one that made the transition from focussing on mine detection and clearance from the ground to looking at how it can be done from the air.

In the 1990s the company began a process of development that succeeded in creating several prototype systems and which culminated in the CamCopter 5.1, a rotary VTOL UAV System. The experience gained from this system was then employed in the development of a VTOL system known as the CamCopter S100 UAV.

The company is based in Austria, but has a presence in the US, the United Arab Emirates and in Cambodia.
Although still a small company, with around 200 employees, it is one that is growing significantly as it transitions from R&D to industrialisation of the S100.

UAV Market Success

For an exclusive provider of VTOL, Schiebel has had a fair degree of success in a market where few purchases have been made within the UAV class. The CamCopter 5.1 was sold to the US Army and was used in Maritime operations by the Egyptian navy.
The successor S100 VTOL UAV has been able to sell to the United Arab Emirates, in addition to a number of undisclosed commercial customers. On behalf of its customers, Schiebel has provided extensive services, including operation of the system in Afghanistan.

Partnerships

Schiebel's key partnership has been with the UAV Research and Technology Centre, based in the United Arab Emirates. This organisation has enabled the company to expand its facilities, contributed to product development, met customer requirements for industrial participation and has also provided testing services.

Civilian Market activities

Schiebel claims to already have a commercial customer which employs the S100 for pipeline security surveillance. The S100 was also tested by the Austrian government which was interested in using the system for border security.

2.21. Sonaca

Company Overview

Sonaca is an aerospace manufacturing company based in Belgium, with subsidiaries in Brazil, Canada and the United States of America. The company partners with Airbus, Embraer, Bombardier and Dassault Aviation among others in the commercial aerospace business, but where defence

contracts are concerned, the company is typically an offset partner to locally manufacture parts for programmes such as the F-16.

UAV Market Success

Sonaca successfully marketed the *B-Hunter* platform in co-operation with IAI for the Belgium UAV requirement, and was involved in manufacturing of components for these platforms.

Partnerships

With regard to UAVs, the company worked with IAI and Thales to build the B-Hunter UAV, based on an Israeli platform.

Civilian Market activities

The B-Hunter has been certified to fly over populated areas, and has been used by Belgium in a number of non-military tasks, including maritime patrol.

2.22. Thales

Company Overview

Thales is a leading global provider of mission-critical defence electronics and information systems, addressing Aerospace, Defence and Civil Security markets. The company is organised on a multi-domestic basis, so while its main strategic decision-making is based in France, the company has expanded across the globe through an extensive series of acquisitions, organic growth and joint ventures. As a result, the company has a significant development and manufacturing base across Europe, which is supporting the company's strategic move to act as a prime contractor and systems of systems integrator (SOSI). Key project wins such as the *Watchkeeper* UAV in the UK have supported this focus.

Whilst the company does not specialise in developing UAV aero-structures, Thales is a UAV systems supplier that is active in developing partnerships to match its capability gaps to provide total UAV solutions.

UAV Market Success

Thales' main success has been in winning the Watchkeeper Tactical UAV programme worth £800 million (€ 1 billion), scheduled for delivery in 2010. To satisfy the immediate demand from operations in Afghanistan and close the capability gap from the UK's early retirement of its *Phoenix* UAV, Thales and Elbit have worked with the MOD to bring into service the *Hermes 450*, known as *Lydian*, which the MOD uses on a Pay Per Usage basis.

In 2007, Thales was awarded a contract by the French DGA to conduct a study to define France's requirements for a VTOL platform. Also on behalf of the DGA, Thales is examining armed, lethal UAV concepts.

Partnerships

Thales has used partnerships with other companies to complement its core competences. As a means of meeting the *Watchkeeper* requirement, the company partnered with Elbit, setting up a joint venture company called U-TacS. The two companies also partnered in providing Elbit's *Skylark* Mini-UAV to the Canadian market in 2004.

Along with Dassault Aviation, IAI and Indra, Thales has made an unsolicited bid to provide a MALE UAV to the French and Spanish governments based on the *Heron* platform. There is a further development with Dassault Aviation, looking at bringing the *Watchkeeper* UAV into France.

Thales Belgium worked with Sonaca and IAI to develop and build the *Hunter* UAV for Belgium

As part of a development to create a versatile missile for UAVs, Thales has utilised the Schiebel CamCopter S100 platform as a test-bed for the integration and test firing of the missile.

Civilian Market activities

Thales has a significant presence in the field of civil security systems and it is likely that the company's expertise in this area will include UAVs. As part of the ASTRAEA programme in the UK, Thales works alongside BAE Systems, QinetiQ, EADS and others to address technological and regulatory issues to operate UAVs in non-segregated airspace.

2.23. Other notable UAV developers

The UAV industry is highly varied and also includes a range of smaller companies, including VITO, INTA and Alpi Aviation. Only a small number of smaller European companies have been able to have significant commercial success, notably Alpi Aviation. In many cases, there has been too much emphasis on the development of airframes within Europe's small and medium sized companies, where real value and innovation must occur in niche technology areas and systems integration.

3. The interdependence of military and civil market business cases

The civilian UAV market, as embryonic as it currently is, depends heavily on solutions originally designed for military applications. Although requirements are obviously different, technological developments for UAVs that will be used in the civil domain are likely to follow paths of equipment currently available for the military for the time being. This technological synergy is expected to change once the demand for civilian UAVs crosses a significance threshold and solutions will then come from dedicated, civil-orientated improvements and will possibly even be re-adapted for military purposes.

There are however two major differences between requirements for the military and civilian markets:

- Whereas the military market places high performance above low costs, the civilian market needs both high performance and low cost. The military market will strive for the lowest cost which will provide them with the required performance whereas the civilian market is unlikely to buy an expensive system even if the performance requirement is met.
- In the military market, reliability is related to the assurance that the system will complete the mission. In the civilian market, the emphasis for reliability is that while performing the task or mission, it does not do any damage to people or property. In addition, if the reliability is low, replacement cost will increase which is also likely to contribute to the elimination of UAS as a potential solution for that particular application.

On the defence side, force protection – risk reduction for soldiers – was and still is one of the major driving factors for UAV developments. Although developed partially with this initial goal in mind, UAVs have also proven to be operationally efficient and more cost-effective than manned aircraft in some types of missions (e.g. maritime patrol). A major trend has been emerging where military UAVs are undergoing technological improvements focussed purely on cost reduction. This shift on the military side foreshadows a profound impact on the development of the future civil UAV markets, where cost sensitivity will be a much greater issue. Our current reliance on relatively high-cost platforms with high reliability procured to reduce soldiers' exposure to hostile situations will shift into procurement of more cost effective platforms with equal or similar capability. A good example of this is the current shift from TUAS to SUAS or even MUAS for artillery spotting. Similarly, many tasks that are expected to be performed by UAVs in the future are likely to be done by much smaller and cheaper platforms than is currently envisaged as payload miniaturisation is increasingly possible without a corresponding reduction of data quality.

At the company level, manufacturers investing in UAV development are still reluctant to divert funds towards the civilian market and are primarily trying to attend to military needs. In spite of the generally accepted notion that adapting military platforms for civil use is likely to be a key driver for the industry in the near future, current market players believe that they have no choice but to concentrate their efforts on military applications due to the bad visibility of what the future civilian market may hold. The exceptions are the companies that have not participated in the market for military UAVs and that are now anxiously waiting for the European civilian UAV market to emerge. In other worlds, platforms and technologies that were not successful on the military side may represent great opportunities for companies that created them provided they are willing to convert their systems to what are known as civil UAV requirements.

It is, however, important to bear in mind that the entire industry is still on stand-by where the civilian market is concerned, waiting for regulations and policies to be defined. Once these become official and are rolled out,

manufacturers are expected to use their military-based technology and redirect it towards civilian applications, with an eye to the potential cost-benefits of UAV use.

On the other hand, it is also already possible to identify Small & Medium Enterprises (SMEs) investing largely in the civilian UAV market. R&D funds are at the moment focussing on payload developments and endurance capability and less on platforms, as these characteristics are unlikely to suffer restrictions from future regulations.

Another key element of the UAV system is the ground control station (GCS) of the UAV, in which human factors are a key element and one worth identifying as an area where significant knowledge and certain training elements can be shared between the military and civilian domains.

Meanwhile, military and civilian markets remain highly interdependent and are likely to, together, conduct UAV developments in a spiral, cyclic approach: solutions for the military now drive the potential civilian domain that are likely to emerge as the biggest market and, therefore, come up with solutions that will eventually be readapted for the military; an infinite development cycle that is highly beneficial to both market and end-users. The European Commission as well as national governments could make a substantial contribution by promoting and funding additional research and technological development that would lead to further reductions in manufacturing, training and operating costs as well as improved reliability.

4. SMEs in the European UAV market landscape

Small & Medium Enterprises are largely present in the European UAV market. Struggling to gain a slice of this market, SMEs are either competing directly or partnering with European Prime contractors in order to succeed.

The European UAV market is expected in time to offer great opportunities for 2nd, 3rd and even 4th tier companies.[2]

[2] European Civil UAV Market – UAVNET / Frost & Sullivan; 2007.

1st Tier	Systems Integrators
2nd Tier	Manufacturers of main equipment (platforms)
3rd Tier	Sub-System manufacturers
4th Tier	Sub-parts producers

Governments and other European Authorities, however, play a crucial role in this context since their actions have a direct impact on the success or failure of SMEs. They operate in different domains in Europe, according to the peculiarities of the market. In order to assess their presence in the region it is important to consider their main characteristics and their market potential, as well as their relationship with Tier One companies and Government procurement agencies.

4.1. Characteristics

Many of these enterprises evolve from University Research Departments or from small initiatives started up by skilled members of the workforce with experience in developing airborne payloads or aero-structures design. The positive results expected from all the UAV applications are driving these research centres and small private companies to invest now in the market. As opportunities in the civil arena are expected to occur across the entire region and in reasonably high volumes for some applications, SMEs offer some advantages in the European market.

The miniaturisation of systems and payloads have tended to be a key area of SME interest. Many are relying on nanotechnology developments for UAV applications, considering that Mini-unmanned vehicles are likely to be the first type to be deployed for civilian use. SMEs, therefore, are expected to be part of the spearhead in technology innovation, creating new solutions in UAV development and bringing them to compete in the market.

Currently SMEs are relying on partnership with 1st tier companies to gain access to the military market. There are a number of reasons why it is an advantage for them to team up with prime contractors. These include:

- the inability on their own to supply/manufacture their products in sufficient volume;
- the inability to integrate their systems with others according to military specific requirements;
- a pervasive Armed Forces' lack of confidence in small firms, who have yet to prove their ability to maintain their supply chain – as opposed to 1st tier suppliers with whom relationships have usually become well-established.

Partnerships of this kind have been considered of paramount importance for the consolidation of SMEs in the sector and represent an important element in their continuing successful presence in the European UAV market. Contracts and partnerships with 1st tier companies allow SMEs to place their products under practical evaluation – either a whole system or individual components, such as the payload. This permits small enterprises to receive end-user feedback and is likely to foster further development/improvement of their technologies. Moreover, partnering with prime contractors has been a great marketing tool for 2nd and 3rd tier organisations to have their technology exposed not only at a national level but also to different prime contractors at the global level.

Additionally, from the prime contractor's point of view, it can be a very cost-effective strategy to partner with an SME. In certain areas, the demand for UAVs has not yet scaled up to a level which justifies major R&D investment. With this in mind, outsourcing for innovative technologies becomes an painless way of extending their technology portfolio, either in the current military or in the emerging civilian sectors. A number of major players have used SMEs in this way – among them EADS, SAGEM, IAI and Elbit.

4.2. SMEs focus

This partnership model naturally works both ways. Their initial experience in the military market is significant to SMES as it provides them with their first exposure to end-users' perception of their technologies. Once demand in the civilian market starts growing, SMEs with an established track record in the military market are likely to be more successful. European SMEs have

demonstrated an ability to be agile and flexible in meeting end-users' requirements: they are often capable of providing a greater degree of customisation than 1st tier companies, and can respond quicker than primes to urgent demand.

However, it is very unlikely that the focus of most SMEs will be entirely on the military segment. Companies such as EMT have been successful in addressing military demands, but the opportunities for small companies usually rely on a different dynamics: a range of separate customers, small sales, and commercial-off-the-shelf (COTS) products.

Taking this into consideration when looking at the emerging civilian UAV market, it becomes clear that SMEs will have to overcome several obstacles in order successfully to grow in the European market. As the civilian focus is initially expected to be on Mini-UAVs, SMEs will have to adjust their business plan accordingly in order to overcome the units vs. costs trade off. As the market opens up initial profits are likely to depend on a high volume of sales instead of small orders based on high-value units, with the former model more difficult to achieve in the civilian sector than in the military market. In this context, business strategy, industry support and government-sponsored regulation are all expected to play important roles affecting the degree of success achievable by SMEs as they struggle for a space in this still emerging market.

In smaller European countries – particularly in Eastern Europe – a number of domestic manufacturers are involved in UAV research but are unlikely to embark upon large-scale UAV manufacturing given the costs, technology requirements and expected level of competition. The initial experiences on the military side illustrate this problem. Some Eastern European countries have already tested domestic UAV platforms with their respective Armed Forces but these have generally not met requirements now based on operational experience or NATO standards. Following this first exposure, some countries have stated that the lack of funds available to invest in the domestic industry, together with the urgent desire to provide their troops with UAV capability forces them to opt for cost-effective technologies that already have proved successful elsewhere, i.e. tier 1 and 2 products. In addition, the prospect of competing with well-funded Western European tier 1 and 2 companies, as

well as SMEs, represents a further restraint on the rise of small Eastern European UAV manufacturers. Unless they have a genuinely new technology for a specific civilian application, SMEs in new EU Accession states are unlikely to grow beyond their domestic markets, which in most cases represent only a small portion of the expected market's potential size.

Further investment in R&D is another issue faced by SME UAV initiatives. As previously indicated, innovative SME technologies often emerge either from University Research Centres, usually directly or indirectly funded by the Government, or from small initiatives created by experts to transfer know-how from the private sector. In a segment where technological improvements occur very quickly and are constantly evolving, deep pockets, to enable continuing R&D funding can be crucial in giving SMEs the ability to compete in the European as well as the extra-regional market. This funding is the key and is often hard to obtain, particularly at a time of acute financial constraint and cautious investment.

In terms of external competition, at the moment SMEs are unlikely to be placed under pressure from players such as China, Japan or South Korea. All three countries have already taken initial steps towards military and civil UAV production and many SMEs are involved in current activity. In South Korea, the public has a widespread awareness of the potential uses of UAVs, so initiatives from potential end-users to experiment with unmanned platforms are giving small enterprises a greater incentive to invest in UAV developments than their European counterparts. In other aspects, market development dynamics appear to be very similar to those seen in Europe: Universities/Research Institutes are designing prototypes; small enterprises rely on integrators (such as KAI) to get initial experience in the UAV market. In Japan, the civil UAV market for some applications (agriculture) is already highly sophisticated, and the military segment is catching up. However, Japan does not allow export of military technology and even Japanese civil UAV manufacturers find it very hard to export their products as they are considered dual use. China and South Korea are not expected to represent an imminent threat to European SMEs unless the UAV technology they offer proves to be extremely cost-effective. A significant number of ongoing projects in Europe

are expected to be seen as more efficient and reliable, especially in terms of operational quality and support services.

Finally, it is important to bear in mind that the emerging civilian UAV market in Europe has particular characteristics that differ in essence from the current military market. The latter is based upon expensive procurements (often over US$100m), high-technology sophistication, involvement with Government bodies (Ministries of Defence) securing long-term contracts that go beyond the acquisition process – through-life approach, training, etc.[3] On the other hand, as previously pointed out, the civilian market dynamics are characterised by a reliance on commercial-off-the-shelf (COTS) products, low investment cycles and less involvement with end-users once the sales process is finished. These features theoretically reinforce the position of SMEs in the market.

4.3. Final Considerations

European SMEs are putting high hopes in the civilian UAV market while trying to gain initial exposure to the market through partnering with 1st tier companies that currently supply the still-growing military market. These partnerships have been beneficial as a means of testing technology and understand what changes and improvements need to be made in order successfully to insert their products into the emerging civilian market.

A major uncertainty concerns the predominant business model that SMEs should employ to explore future opportunities in the European UAV market.[4] Airframe manufacture, payload development, sub-systems innovation, pay-per-usage (PPU) and/or the provision of after-sales support are some of the possibilities. Success will depend upon either SMEs' own ability to understand the market or by institutional initiatives designed to orientate small and medium enterprises towards the best option.

Competition will also dictate the future participation of SMEs in the European market. Israeli and US technologies are already a main pillar for European platforms, and both countries have stable industries capable of competing on

[3] European Civil UAV Market – UAVNET / Frost & Sullivan; 2007.
[4] European Civil UAV Market – UAVNET / Frost & Sullivan; 2007.

both fronts: airframe production and systems integration. Again, institutional action could be crucial in ensuring that SMEs are able to secure a competitive position in the European market.

The degree of European Government participation, at either the national or EU level, is not restricted to that cited above. It does in fact have a much greater role and demonstrates the impact that institutional bodies can have in the current and future success of SMEs in Europe. There are two further key factors which need to be addressed: the issues of UAV culture and institutional funding.

Firstly, future UAV end-users, such as in the oil and gas infrastructure sector, are normally willing to participate in trials, sometimes even direct a small amount of investment towards UAV development. However, they are not entirely convinced of the beneficial applications of UAVs in general.[5] Also, potential end-users are not yet sure about the impact that restrictions and/or certification will cause in the market. There is therefore an urgent need for further demonstrations off UAV use. Once the technology is shown to be reliable and effective – and military activities are mainly responsible for this at the moment – the use of UAVs must be acknowledge as a viable alternative to manned platforms. Major players in the industry also have concerns that, at this point, negative coverage of military UAV activities may be harmful to the emerging civilian market. The need to foster a dynamic and positive UAV culture within Europe is essential for this technology's future; and institutional bodies might work together with SMEs to market the idea of UAVs to potential end-users and overcome this initial awareness barrier.

Secondly, many of the funds currently available for UAV R&D are directed to integrators (1st tier) rather than SMEs. Switching investments to 2nd, 3rd or even 4th tier companies is likely to help fuel the development of innovative solutions and also to initiate the emergence and rise of a solid industry in Europe.

The most effective way of ensuring future SME participation in the European UAV market is therefore the presence of a degree of government and EU support. It requires a significant effort from decision makers to educate

[5] European Civil UAV Market – UAVNET / Frost & Sullivan; 2007.

industry and foster the idea of UAV applications among potential producers and end-users. SMEs, Universities and Research Centres, as well as other UAV manufactures already investing or planning to invest in this emerging market are all awaiting the roll out of regulations and certification standards before readily committing to major further investment. Once regulation is in place and understood SMEs are likely to demonstrate a greater interest in the UAV market. A combined, co-ordinated approach to policy is likely to be a determinant factor in positioning the European UAV market in the near future, where collaboration, innovation and co-ordination must occur between SMEs, end-users and, indeed, the European authorities.

5. Overview of the political situation concerning the use and production of UAVs

National, European and international agencies are working closely together to converge on, develop and eventually to produce a coherent body of mutually-agreed legislation, protocols, and technologies. These will enable the certification and operation of UAVs in not just European but also global, controlled airspace. The benchmark for this is that UAVs should operate at an equivalent level of safety ('ELOS') to manned aircraft.

There have, however, been major obstacles preventing political action from achieving the rapid creation of regulations and their integration within the national, regional and global contexts:

- Industry is very fragmented;
- The use of UAVs in controlled airspace continues to suffer from the absence of coherent national or EU-wide air-traffic management (ATM) and other legislation, airworthiness certification and established flight rules which govern the movement of all but the smallest systems;
- Technical issues, such as the radio frequency (RF) spectrum (bandwidth) for command and control as well as payload (sensor) datalinks, are not yet allocated on a standard, global scale (standardisation).

UAV manufactures as well as potential end-users are waiting for a combined initiative from national and supra-national authorities in order to move forward on both the investment and technical design fronts.

At the moment, the natural course of the UAV market has followed an inverse path to what would be the ideal way to promote policies within this domain: starting from the national level and moving then to supra-national authorities. In other words, embryonic decisions regarding regulations and other policies have not been implemented in an organised way, on the contrary. This situation is the result of having inherited rules and standards based upon those already covering manned aircraft which are being adapted for application to UAVs. This has led to a profusion of locally-grown practices which now have to be integrated into a single, coherent whole, which must also be agreeable to all those stakeholders involved.

5.1. National perspective

The principal concern at the national level will generally be a desire to foster the development of a healthy domestic UAV industry. And in this context, individual governments will have to deal with manufactures ranging from SMEs to large companies.

Whilst the former may initially suffer from a lack of funding and the robustness required to deal with future risks and opportunities, big companies with technology applicable to the UAV market are likely to be mostly focussed on profitable military sales, leaving little investment resources available for the commercial sector. Measures should therefore be taken in order to promote strong policies which support each level of manufacturer in order to assure that all expected opportunities can be addressed by national industry. A possibility to be considered is the allocation of financial and legislative incentives to promote the development of UAV systems and sub-systems (airframe, payload, S&A technology, ground station design and development, training systems, etc.) and spread it between SMEs, academic and industry research bodies, and big aerospace companies, among others. In other words, government can take advantage of its authority to promote the

development of the UAV market among all its participants at the national level as well as to create policies that will mitigate risks and needs for the consolidation of domestic industry.

5.2 European perspective

For European authorities, the airspace usage issue seems to stand out as the prime impediment to progress, and therefore the first factor that needs to be addressed. Issues include the integration not only of both civilian and commercial UAVs with civil air traffic but with other State and military aircraft as well.

In order for reliable, safe operation of UAVs in European airspace to be guaranteed there need to be common rules governing UAS design and operation across the entire region. Such Regulations will rely upon agreed standards of airworthiness certification. The granting of airworthiness Certification in turn will be impossible for UAVs operating in the same airspace as other aircraft of all types (both civil and military) without a reliable, foolproof, sense and avoid (S&A) capability that guarantees the safety of the over-flown population. This S&A technology is currently regarded as something of a 'grail' in the industry, and is some years away from a working, commercially viable model. Some industry pundits are asserting that no new technologies are necessary to build such a system but, although this is strictly true it is also misleading. In order to bring a working model to market a great deal of work remains to be done in terms of integration, power consumption and miniaturisation in order to make it suitable for use on a UAV, of any size. One of the most frequently quoted advantages of a UAV is that it does without the weight of a pilot. If the S&A module weighs in at more than a stout pilot that particular advantage is lost at a stroke.

The availability of appropriate, safe (robust, jam-proof) and secure (third-party intrusion proof) communications is also crucial to the routine operation of UAVs. Loss of radio contact is a prime cause of UAV failure in the military sector.

- There is no standard band in the RF spectrum assigned to UAVs, either nationally or regionally. Frequencies are allocated by individual States as

and when required, in much the same way as Exemptions are issued for UAV flights in controlled airspace.

- Europe's RF spectrum is already overcrowded, and the availability of suitable, secure frequencies for both command and control, and datalinks is another major bottleneck to progress. Intense demand also means bandwidth is expensive.
- An ITU decision is expected in 2011 following the WRC-11 conference which is supposed to address this issue on a global scale. Actual results arising from any decisions made are unlikely to have any impact until several years thereafter, however, as decisions are phased in over time in order to accommodate regional adjustments.
- In the interim, the EDA is working on allocating areas of the RF spectrum for UAS at the European level. Meanwhile, the EDA has initiated plans to fund a project which will identify areas of the frequency spectrum suitable for use UAS within Europe. These dedicated frequencies, once established, and segregated, could then be made available to users.

5.3 Global perspective

Still within the compass of political perspectives from the European level, it will fall to international authorities with global reach to establish operational requirements for the use of UAVs – again working in collaboration with regional and state-level decision makers. The RF question is, for example, one of the issues where such international institutions must work together. [6]

It is encouraging that not just European institutions are working together but there is also a high level of co-operation across the Atlantic. Working groups on both sides of the ocean have members in common and appear to be working towards a common goal. Differences in policy and priorities have emerged between North American and European groups, but no irretrievable rifts have yet come between them. The principal impediment to swift

[6] The RF spectrum issue is being studied and a decision expected at the next ITU (International Telecommunications Union) World Radiocommunication Conference (WRC), but this is not scheduled to convene until 2011 (WRC-11). In the interim, frequencies are being allocated on demand and according to availability, in a similar way to airspace exemptions granted by regional aviation authorities.

resolution is the shear number of stakeholders involved. Many of these have their own interests to safeguard and the process of drawing everyone together is understandably slow. Nevertheless, progress is being made and there are renewed efforts to address industry's frustration by looking at other ways of achieving a solution, through a phased approach for example, in place of the 'Big Bang' solution originally envisaged.

Ideally, definition of airworthiness certification, air traffic management and safety (communication and S&A sensors) would be the first factor to be addressed by regulations, and international bodies should be the ones defining these requirements and policies in a combined and collaborative effort between international bodies, regional authorities (EU) and individual governments, and this is indeed what is taking place. Once a consensus has been achieved, other competences specific to each political level are then to be considered so manufacturers and end-users can grain a better picture of what the UAV market will look like.

5.4 Public Funding

Whilst the private sector has been slow to devote substantial investment in civil and commercial UAS, concentrating instead on the still-lucrative military sector, public financial support has played a vital role.

Government funding, notably at the supra-national level, has been fuelling the vital co-ordinated development of common policies and standards through EUROCONTROL, EUROCAE (European Organization for Aviation Equipment) and EASA (European Aviation Safety Agency) and also NATO, as well as a series of EU initiatives such as USICO, UAVNet and CAPECON. But these latter groups, drawing their membership from industry, government bodies and academic institutions, have now mostly reached the end of their funding cycles. Other official funding has been channelled through university departments and regional government development authorities, for example, to assist with R&D projects developing prototype platforms and systems. Perhaps one of the most high-profile and ambitious examples of this model is the ParcAberporth facility in West Wales, supported as a 'centre of excellence'

by the Welsh Assembly Government in an effort designed to attract industry participants – and investment – to the area.

Following a well-travelled route, many of these officially-funded projects may eventually be spun off into the private sector as SMEs, or be absorbed into larger, existing aerospace companies.

Meanwhile, however, 2008 has witnessed something of a renaissance: funding has once again become available from the EU and EDA, and there has been a visible effort to breathe new life into what had become a moribund regulatory process, its momentum hampered by the immensity of the task in hand.

In 2007, the EDA had a budget of €6 million (about $US9.4 million) to support the UAS sector. It invested €0.5 million (about US$780,000) in commissioning the development of a Roadmap for the UAS insertion into General Air Traffic by 2015. The 'Air4All' consortium is led by BAE Systems, and includes many of Europe's leading Aerospace companies, which have been brought together to thrash out a result that is keenly awaited. On the hardware side, EDA also launched a €4 million ($US6.25 million) project in 2007 to a consortium of European companies for the development of a Mini Aerial Vehicle Demonstrator – MAVDEM. Although the device is primarily designed for military use, but it would have potential civilian applications as well. Prototypes are due for flight tests in late 2008.

Public funds have also played a role in partnership with industry. For example, ASTRAEA (*Autonomous System Technology Related Airborne Evaluation and Assessment*), inaugurated in 2005, is the United Kingdom consortium whose brief it is to "lay the foundations for opening up UK airspace" to UAS.

With a €40.4 million (£32million) budget, ASTRAEA is jointly funded by government and industry, with each sector providing roughly half the total.

Its broad brief is to examine the now familiar requirements in terms of technologies, regulatory approval and certification, pilot training, and dedicated bandwidth and frequencies for communications needed to facilitate routine UAS operations.

ASTRAEA is regarded as a role-model for how industry, central and regional government development authorities, academic institutions and regulatory authorities should be collaborating in order to promote the use of UAVs.

6 Overview of the current status of social acceptance of UAVs

Social acceptance of UAVs in Europe has two clearly distinct domains: when operated by the military in war zones (in-combat UAVs) and when operated in civilian airspace. While the first enjoys the usually enthusiastic support not only of the armed forces directly but also of the general public, the second raises a number of issues, particularly in a multinational European environment. Much more needs therefore be explored in order to understand the issues surrounding the use of UAS in civilian airspace. The military benefits of UAS are now well recognised and documented. It is important, however, to understand the correlation of this with the way the European public perceives the use of unmanned aerial vehicles in the wider environment.

Firstly, the military use of UAVs has established a very constructive image for the future of this emerging technology. Military operations involving UAS have had a highly positive impact. As tolerance of casualties reduces every year, the use of unmanned platforms is becoming recognised as a way of protecting troops, and of avoiding putting them in harm's way. In other words, UAV deployment reduces the risk of battle casualties.

Arguably though, awareness of the life-saving potential of UAS is not yet widely diffused among the public at large. Whilst the Armed Forces and the defence industry are well aware of their many other advantages as well; there has been still only limited coverage of UAV activity by the media world-wide, and this has little to do with any secrecy surrounding their operations.

Nevertheless, it is expected that social acceptance will increase considerably once the technology's applications become more widely known. At present pilotless aircraft are at a similar stage to that which characterised the introduction of the horseless carriage: the motor car, almost exactly 100 years ago. At first they could only operate if preceded by a man waving a red flag. But it didn't take long for the public to embrace the new technology as its advantages became manifest and the idea caught on. The impact the media

can generate in promoting the use of UAS is as yet un-quantified. However, its ability to influence public opinion – one way or the other – will be a significant factor in the successful introduction of UAS into the civilian domain.
UAVs operating in non-segregated airspace exist in an entirely different environment. In this context, civilian UAS have to cope with so many different factors compared to their military counterparts that adaptations or the conversion of military platforms and systems for civilian use are often impractical. Moreover, civilian applications of the technology have been developing at a much slower pace, constrained as they are by the regulations governing their construction, specification and operation. Or rather by the absence of these regulations.
By comparison, military UAVs used in war zones fly in hostile air space that is intensely observed and controlled, to the exclusion of non-military traffic. Consequently, UAVs deployed in combat pose no significant threat to the safety of air traffic management (ATM), nor do flight regulations represent an obstacle in this context. It is important to bear in mind, however, that such an assessment is only sustainable while UAVs are still being used at current levels; increased usage of UAVs – the concept of the UAV/UCAV 'swarm,' is gaining popularity – is expected to require a greater degree of convergence and regulated standardisation, even in the military sphere.
In the European context, as it is in other densely populated locations, social acceptance is directly related to reliability. The benchmark criterion for a UAV flying in civilian airspace is that it should be able to do so at an "equivalent level of safety" to manned systems. This baseline requirement has now become so established that it has acquired its own acronym and is often simply known as 'ELOS'.
The use of UAS in civilian air space is likely to become more conventional once the necessary technologies prove to be reliable, safe and effective. Once this has been achieved, regulation based upon the available technologies can be rolled out. In this respect, the swift incubation and maturation of the technology is therefore crucial.
The introduction of civil and commercial UAS has so far been hampered by a number of inter-related factors. In order to fly in the same airspace as manned aircraft UAVs need to meet the equivalent safety criteria ("ELOS"). However,

these need specifically to be defined by airworthiness Certification requirements and ATM rules. In order to establish these rules and criteria certain practical, engineering-based problems need to be solved first. Chief among these priorities are the production of an effective Sense and Avoid (S&A) or anti-collision system and the allocation of standard, dedicated portions of the radio frequency (RF) spectrum suitable for secure UAS command and control as well as payload datalinks.

Efforts dedicated to the achievement of these goals are being intensified, in North America as well as in Europe where progress has been losing momentum. Where possible, and in order to avoid reinventing the wheel, the development of guidelines (precursors to regulation) governing airworthiness certification as well as ATM rules is being achieved by adapting existing regulations covering manned aircraft.

Nevertheless, it has become evident that this was always going to be a labyrinthine task whose complexity had been dramatically underestimated.

At the root, effective regulations rely upon the successful integration of failsafe technologies into UAVs designed to fly in controlled (i.e non-segregated) airspace. And at the core of these vital technologies is an effective S&A or anti-collision system which will cope with deconfliction and the separation of the aircraft from other airspace users, manned and unmanned, civil and military, using the same airspace. Manufacturers have suggested that no new technologies are required to make this happen. Whilst it remains questionable as the specifications of such a system are not ready yet, the issue is not whether the technology exists, but whether it is available, now, in a form usable to UAS. It is not. In order for it to become viable for use aboard even some of the larger platforms the hardware will need to be miniaturised and its power consumption reduced. The integration of systems will also absorb significant resources before a finished product becomes available. Optimists see this happening in 2015 at the very earliest. It will then take time to bring finished systems(s) into commercial production, and thence to market.

The long march towards a coherent, European set of regulations is being co-ordinated by EUROCONTROL, which is working closely with European national aviation authorities through EUROCAE (European Organisation for Civilian Aircraft Equipment). The Working Group of experts responsible for

drawing up the rules, EUROCAE's "WG-73", is also working with other European and international bodies including the European Defence Agency (EDA), EASA (European Aviation Safety Agency), NATO (whose STANAG 4671 is regarded as a keystone in the development of a UAV legislation edifice), the FAA in the United States, ICAO, and those groups responsible for standards outside Europe.

The background against which the development of a regulatory framework is taking place is one of considerable complexity. EUROCONTROL is composed of 38 member states, each with its own set of rules and priorities. Just one of the committees dealing with a particular aspect of the required regulation has itself more than 1,000 members. EUROCAE is briefed to provide recommendations for MOPS (Minimum Operational Performance Standards), which form the basis of future legislation. These are only achievable through agreement by consensus among the range of stakeholders.

Little surprise then that progress to date has been characterised as "glacial". But the stakes are high: the need for solid, reliable standards is fundamental to future safe operations. Accidents, already high profile events in the manned aircraft world, would give the news media a field-day if a UAV was involved, generating public panic and placing a fresh obstacle in the way of progress.

Nevertheless, efforts at breathing new life into the process are being made, notably by the EDA. It has sponsored initiatives in an attempt to pick up the pace, naming 2015 as the year in which UAVs will fly in civil, controlled airspace.

Many see this as ambitious, with the date closer to 2020 or even later. But the gauntlet has been thrown down and it has helped to refocus efforts on reaching solutions by the shortest route, without compromising on quality. Alternative approaches and options are also being examined.

Progress in the SESAR (Single European Sky) project, running in parallel, also has relevance for the integration of UAVs into controlled airspace. Although implementation is not due until 2020 onwards it does provide a framework within which UAS will be obliged to operate, and provides further guidelines for those involved in the development of UAS legislation. An EC FP6 project named INOUI (Innovative Operational UAS Integration) aims at helping SESAR to consider the UAS case.

Once airworthiness certification and flight rules have been established, OEMs will have a clearer idea about what specifications will be required when developing and building systems for the civilian and commercial market. At the moment, even the ergonomics, the control interface, vary widely between manufacturers, and even between systems coming from the same source. Road vehicles, as well as aircraft, even 100 years ago, soon began to feature common controls recognisable to potential users around the world. The same cannot be said of UAS. Convergence on GCS standards would assist with pilot training and reduce costs in other areas as well.

At the moment, civil UAV flights in non-segregated airspace require Exemptions from local aviation authorities, and if the platform has a mass in excess of 150 kilos it would require clearance from EASA. Such an ad hoc system is cumbersome and continues to delay the routine operation of UAS outside segregated airspace. Similar issues apply when attempting to find suitable, usable radio frequencies for UAV missions. In order to avoid either accidental corruption of the signal or deliberate sabotage, links need to be secure. Failure to guarantee security could lead to an accident, with its consequent impact on public confidence. In Europe, no areas of the RF spectrum have been allocated exclusively for UAS use. Frequencies are issued on demand, according to availability. Again, this has not encouraged the introduction of regular UAS operations. The subject's technical and political aspects are scheduled for discussion at the next ITU conference (WRC-11), but this does not convene until 2011. Meanwhile, the importance of reaching a swifter conclusion has been recognised, and one of the initiatives supported by the EDA is designed to bring forward the achievement of European progress in this area.

The fundamental issue, therefore, is that of safety. Without measures designed to provide an acceptable level of safety, public acceptance of UAS will not be achievable. The maturing mobile telephone industry has weathered outbreaks of negative publicity, only to see these fade as social acceptance grows with the spreading recognition of the technology's obvious benefits. As UAS achieve routine use, gradually at first, supported by reliable technologies and a framework of rules designed to ensure safe operation, social

acceptance will become the norm. Most previous breakthrough technologies, from the wheel to the internet have brought risks along with social benefits. It is for the public mind to measure the advantages against the risks. When the dangers are eclipsed by the rewards, social acceptance is swift and usually irreversible.

7 Preliminary recommendations

7.1 Industry side

- Industry's prime focus should continue to be on the specification (including involvement in the rules definition process) and subsequent production of an effective collision avoidance solution. This will need to be of a standard which will assure an equivalent level of safety ('ELOS') to that already enjoyed in controlled airspace presently occupied by manned aircraft alone. It will involve the development and integration of existing technologies in order to provide sense and avoid (S&A) systems for the entire range of UAV types, as well as for manned aircraft. Engineers and systems integrators will need to work collaboratively with legislators instead of each waiting for the other to take the initiative. The EU Commission, Council, the EDA and other official bodies could play a valuable role in supporting and co-ordinating this process.
- In the longer term, it is in the interests of manufacturers, systems integrators, suppliers and other stakeholders, both in industry and elsewhere (e.g. government and academic research projects, and government departments) to collaborate until the market has matured. If they fail to do so they run the risk of succumbing to energetic foreign competitors, notably from America and Israel, eager to build a position in the potentially lucrative European market.
- Whilst the design and manufacture of a UAV airframe is perhaps one of the least technologically sophisticated aspects of UAV development, its importance should not be overlooked since the platform is the most visible – and recognisable – component of a UAS, and its 'brand'. It is the part the customer sees and identifies.

- SMEs can continue to contribute in a significant way. They will be particularly effective in developing technology for use in specialist niche applications. They may evolve out of academic research departments or develop out of an individual, or group of individuals, with expertise in a particular field.
- SMEs and small research projects will often find themselves collaborating with larger technology companies with an established brand, industry experience and ready access to the market. Such partnerships should be encouraged, nurtured and husbanded, whether informally through the fostering of contacts between industry and innovators – and potential investors – or through government-backed funding or facilitative legislation.

7.2 Political side

- The maintenance of impetus towards increased integration and convergence in the formulation of regulations governing the use of civilian and commercial UAVs is crucial; it is, rightly, the primary focus of concern for the time being, and the area in which the political dimension has the most impact. However, whether in airworthiness certification, in ATM or in the allocation of radio frequency (RF) spectrum, the number of working groups, special committees and other bodies focussing on often overlapping areas of interest needs to be winnowed down to a minimum in order to avoid duplication of effort, and even potentially conflicting positions. Such a rationalisation should also reduce the cost and the time being spent in reaching a coherent outcome. At present the level of co-operation and the unity of approach is commendably high, between industry, legislators and the military (including NATO), as well as between member States, but there is still considerable room for improvement and the concentrated streamlining of effort. This will only be achievable however if those stakeholders with specific interests, that may be in conflict with those of others, accept that there may a need for a degree of compromise ‘for the greater good’: the success of the European UAV industry as a whole.

- There is also a need for a more constructive and proactive collaboration between industry – on the engineering side – and those working in the legislative and political fields. Current behaviour has led to a ‘chicken and egg’ culture, with each side waiting for the other to come up with ideas, and solutions. Result: stagnation and deadlock.
- Well designed legislation and financial support – whether actively, though official funding, or indirectly through tax mitigation, for example – can be effective in facilitating and nurturing success, particularly for emerging and developing businesses.
- Official funding and legislative support should go beyond that destined for the development and establishment of regulations affecting the operation of UAVs in controlled airspace, however. Effective governance and appropriately targeted official funding could also reach into the commercial arena, actively to encourage the growth of a robust European-based UAV sector. This should be capable of addressing a broad, comprehensive market: from initial airframe design through the development of avionics systems and payloads technology development, to the training and through-life support (MRO) functions.

8 List of abbreviations

ATM – Air-Traffic Management

ASTRAEA – Autonomous Systems Technology Related Airborne Evaluation & Assessment

CAA – Civil Aviation Authority (UK)

CONOPS – Concept of operations

COTS – Commercial-Off-The-Shelf

DGA – Délégation Générale pour l'Armement (France)

DoD – Department of Defence (US)

EASA – European Aviation Safety Agency

EDA – European Defence Agency

ELINT – Electronic Intelligence

ELOS – Equivalent Level of Safety

ESA – European Space Agency

EUROCONTROL – European Organisation for the Safety of Air Navigation

EUROCAE – European Organisation for Civil Aviation Equipment

FAA – Federal Aviation Authority (US)

GPS – Global Positioning System

HALE – High Altitude Long Endurance

INOUI – Innovative Operational UAS Integration

MALE – Medium Altitude Long Endurance

MAVDEM – Mini Aerial Vehicle Demonstrator

MoD – Ministry of Defence

MTCR – Missile Technology Control Regime

MUAS – Mini Unmanned Aerial System

MUAV – Mini Unmanned Aerial Vehicle

ONERA – Office National d'Études et de Recherches Aérospatiales (France)

PPU – Pay-Per-Usage

R&D – Research and Development

RF – Radio Frequency

S&A – Sense and Avoid

SESAR – Single European Sky

SME – Small and Medium-sized Enterprise

STANAG – Standardisation Agreement (NATO)

SUAS – Small Unmanned Aerial System

TUAS – Tactical Unmanned Aerial System

TUAV – Tactical UAV

UAV – Unmanned Aerial Vehicle

UAS – Unmanned Aerial System

UCAV – Unmanned Combat Aerial Vehicle

UOR – Urgent Operational Requirements

VTOL – Vertical Takeoff or Landing

WWUAVC – West Wales UAV Centre