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STUDY ANALYSING THE CURRENT ACTIVITIES IN THE FIELD OF UAV

Second Element: Way forward

“What vision can be drawn for Europe in this technology domain and what needs to be done to make it happen”
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1. Current and Future European UAV Market Situation and Requirements

1.1. Analysis of Recent, Current, and Potential UAV Procurement

UAV technology has matured to an extent that has enabled the capability to become a key asset in military organisations across Europe, which has enabled the market to expand considerably during the last decade. On the other hand, the civil and commercial market for UAVs is in its incipient phases with significant unrealised potential in a wide number of applications where the available technology offers the opportunity to replace existing solutions and potentially to be applied in new areas where there is no existing solution.

To understand the UAV market and its future potential, it is often compared to the emergence of Early Flight and conceptualised in a similar way.

1.1.1. Military Procurement – Historical Overview

Unmanned Aerial Vehicles have a longer and richer history than they are often given credit for, with first flight of a heavier than air, unmanned vehicle achieved in 1896 by Mr Samuel Langley’s Aerodrome system. UAVs were utilised on military operations in Vietnam, by Israel in Lebanon, and in every subsequent conflict following the Gulf War. The US and Israel have really pioneered the adoption of UAVs for military applications, with European States beginning to make use of the technology on military operations from the mid-1990s. Early experiences in Bosnia and Kosovo at times proved to be problematic and to have little major influence on situational awareness in theatre, where deception, immature technology, weather conditions and most importantly a lack of understanding in how to best utilise UAVs combined to make an inauspicious beginning to the market in Europe, at least when compared to the growth since 2003.

Research conducted by Frost & Sullivan has indicated that between 2004 and 2008, the number of UAVs deployed globally on operations has increased from around 1,000 to 5,000 systems. The great majority of this growth is
driven by the United States, whose budget and current need is larger than any other country or region in the world.

European and United States forecasted future investment in UAV procurement is compared below:

Whilst the US is set to remain the larger market, particularly in the military field, Europe is growing at a considerably faster rate, particularly in the short-term. In both the US and in Europe, the markets rapid growth has been consolidated around clear definable segments outlined in the chart below.
This segmentation has emerged remarkably quickly and enabled UAVs to replace manned aircraft (such as Global Hawk gradually taking over from the U2, or the Predator taking over from the Canberra PR9), and offering new ‘organic’ surveillance capability to Land Forces. The emergence of hand-launched UAVs in particular has contributed to wider use and experience of UAVs in smaller countries in Europe, which may not otherwise have been able to afford larger systems.

It is apparent that European military organisations (and indeed manufacturers and system integrators) have been gradually building up a critical mass in the experience and utilisation of UAVs to the point where countries across the European Union are all either using UAVs or planning on procuring UAVs in the future.

1.1.2. Key Civilian UAV Application Markets

Although it has yet to materialise, the market for UAVs in civil and commercial applications can be segmented a number of different ways. However, a consensus about how best to apportion this segmentation is beginning to emerge, and is illustrated below:

- **Government**
  - Law enforcement (Police, Civil Security)
  - Border security
  - Coastguard

- **Fire Fighting**
  - Forest fires
  - Other major incidents
  - Emergency rescue (e.g. Mountain rescue)

- **Energy Sector**
  - Oil and gas industry distribution infrastructure
  - Electricity grids / distribution networks

- **Agriculture Forestry and Fisheries**
  - Environmental monitoring
  - Crop dusting
  - Optimising use of resources

- **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

It is expected that these markets will not emerge simultaneously but experience will permeate between different sectors as UAVs are increasingly used. Government users are expected to be the first adopters within the civil market, based on knowledge of past and ongoing activities.
For the most part, to judge the potential size of the civil UAV market, it is important to look at the legacy installed base that is currently in use, in order to ascertain potential replacement of equipment such as Light Aircraft or Helicopters with UAVs.

Also of significance is military procurement, since it is expected that in the short-term, UAVs ostensibly purchased for military activities will additionally be utilised in civil applications, such as maritime patrol or security for major events. It is also true that military experience of UAVs can percolate into wider government and commercial application markets.

The main advantages of using UAVs for civilian purposes are broadly similar to those applicable in the military context. These include, persistence, cost-effectiveness and the ability to function in an environment hazardous to human occupants.

However, perhaps more so than in the military sector, UAV use is limited by cultural issues, where pilots are more opposed to a transition to UAVs in particular applications. It is also true that legislative and regulatory factors are making the emergence of the market significantly delayed. As such, developments and experiments are ad hoc and unco-ordinated.
1.1.3. Country by Country Analysis (Current and Potential UAV Procurement)

**Austria**

*Military*

Austria has currently only experimented with UAVs and to date has not proved to be a strong market for military UAVs. However, it is expected that Austria will procure Tactical UAVs and Mini-UAVs in the medium-term.

![Austrian UAV Procurement, 2008-2017](chart.png)

**Civilian**

Austria has made some significant steps in the utilisation of UAVs in non-military applications, with the Austrian Ministry of Interior successfully testing the Schiebel S-100 VTOL UAV in exercises patrolling the border with Slovakia. This test allowed co-operation to take place between Austrian and Slovakian police and military personnel to operate the UAV across several missions conducted over two weeks.

To date, no procurement is known to have been made but there are promising signs that Austria is pro-active in the use of UAVs for non-military purposes.

Austria is rated as having a high likelihood of using UAVs for Law Enforcement and Border Protection purposes.
Belgium

Military

Belgium has been able to gain significant experience with UAVs through deployment of its Hunter-B system to Bosnia in 2005 and the Congo during 2006. It is worth noting that during the Congo mission, the crash landing of a Belgian military UAV killed a civilian.

Belgium’s modernisation plans are focused around its future development plan, looking towards modernising its military in the period around 2015. The focus for UAVs will be on providing situational awareness in Urban Terrain, and as a result, it is expected that Belgium will invest in both Mini-UAVs from around 2010 and in the replacement of its Hunter-B TUAVs from around 2014. Belgium is likely to acquire MALE UAS, also around 2014.

Civilian

Belgium has been pioneering the use of UAVs in its territorial waters for maritime patrol. Belgium has also extended its use of UAVs for pollution detection and in assisting with forest fire detection, and looking at how to integrate UAVs into Air Traffic Control systems. The Hunter UAV in use with the Belgium military has been certified as airworthy to fly over populated areas in Belgium.

Belgium is viewed as having a high likelihood of using UAVs for Law Enforcement.
**Bulgaria**

*Military*

Bulgaria is in a process of widespread modernisation of its military forces to meet NATO force requirements. It is expected that Bulgaria will seek to attain capability with small investments in Mini-UAVs initially, before investing in Tactical UAVs. A local manufacturer, Armstechno has built a mini-UAV in anticipation of the requirement in the coming years.

![Bulgarian UAV Procurement, 2008-2017](chart)

**Civilian**

Bulgaria has discussed the opportunity to utilise its UAVs in civilian tasks such as maritime patrol and border control.

**Czech Republic**

*Military*

The Czech Republic has been utilising its Sojka-III UAVs designed and built domestically by the Czech Air Force Research Institute (VTUL). The Czech Republic initially focused its investment on upgrading this platform, but it is increasingly likely that new systems will be procured to take advantage of the significant technological advancements made since the Sojka-III was procured. Additionally it is expected that Mini-UAVs will be procured to ensure the Army has sufficient organic ISTAR capability for force protection purposes.
Civilian
Currently there are no UAS registered to fly by the Czech Civil Aviation authority and no petitions have been made to fly UAVs in Czech airspace outside of the military, despite several development programmes in the country.

The Czech Republic is rated as having a low likelihood of using UAVs for civilian purposes, but may do so in Law Enforcement and Border Patrol activities, if at all.

Denmark
Military
Denmark has so far had mixed results with its use of military UAVs, which has significantly delayed potential future acquisitions. Nevertheless, this has provided some useful hands-on experience. Denmark is currently procuring Mini-UAVs, but it will be some time before its Armed Forces commit once again to buying a larger UAV.
Civilian

Denmark is rated as having a good likelihood of utilising UAVs in Coastguard activities, and potentially for Law enforcement.

Estonia

Military

Estonia has a very limited budget for defence and is unlikely to procure any military UAVs above the size of hand-launched mini-UAVs. Currently, the Estonian Army is looking at domestic solutions, which cost less than those on the international market.

Civilian

Estonia is rated as having a strong likelihood of utilising UAVs for border security.
**Finland**

*Military*

Finland has attained a significant amount of experience in the use of UAVs with its procurement of Super Ranger Tactical UAVs. The main initiatives currently ongoing are led by the Air Force, who are looking at two studies simultaneously looking at the utility of Mini-UAVs and one looking at deep penetrating jet UAVs, similar to the CL-289.

As much as possible, Finland is expected to look to its domestic industry to supply its UAVs, and it is notable that Patria has developed a Mini-UAV in anticipation of the requirement emerging.

![Finland UAV Procurement, 2008-2017](image)

**Civilian**

Finland is rated as having a strong likelihood of utilising UAVs in a wide range of civilian applications, the most likely being in Border Security and Fire Fighting but also in Coastguard missions, in the energy sector and in Agriculture and Earth Observation.

**France**

*Military*

France is one of the most experienced users of military UAVs in Europe, with significant expertise centred in the 61<sup>st</sup> Artillery Regiment, which uses CL-289 and Sperwer UAVs.

France is currently procuring significant numbers of the DRAC UAV, in a contract ongoing to 2012. Also of significance is the likely procurement of
replacement TUAVs and significant purchases of MALE UAVs. A number of different French companies are building partnerships to bring in Israeli or US developed platforms with French technology to meet this emerging requirement.

It is also worth noting that France is likely to seek to procure jointly with other countries, with industry making joint offers to France and Spain in particular.

**Civilian**

France is expected to utilise UAVs across a wide range of civil applications, particularly for Law Enforcement.

**Germany**

**Military**

Germany has a strong track record in the use of UAVs and is looking to acquire the full spectrum of UAV capabilities, more so than any other European country.

Germany’s headline procurement is the EuroHawk HALE UAV, which will be utilised in a SIGINT role. Germany has also speeded up its plans to procure MALE UAV to meet ongoing operational requirements, and is expected to make a purchase decision in the near future.

Germany’s current extensive inventory of UAVs will also likely be replaced with new systems during the next ten years. In particular, Germany is interested in the potential for micro-UAVs and for VTOL UAVs.
Civilian

Germany is rated as having a high likelihood of utilising UAVs in civilian applications, with particular focus on Law Enforcement, Energy Sector, Border Security and Agriculture.

Greece

Military

Greece has attained some experience through the use of its tactical UAVs, and is likely to become a market of interest in the future. It is believed that Greece will follow a bottom-up approach to expanding its UAV inventory, with Mini, Tactical and MALE classes procured in 2014-2015.
Civilian

Greece is rated as having a very strong chance of utilising UAVs in civilian applications with notable focus on tackling Forest Fires and in Border Security.

Hungary

Military

Prevailing budgetary constrains in Hungary are likely to frustrate any significant procurements of UAS larger than Mini-UAVs for the foreseeable future.

Civilian

Unlike in the military field, Hungary has proven to be active in the use of UAVs for civilian purposes, with experimentation taking place with UAVs in the role of Fire Fighting.

Hungary is rated as a strong opportunity for utilising UAVs in civilian applications, largely for Fire Fighting and Border Security.

Ireland

Military

Ireland has procured a limited number of Aeronautics Orbiter UAVs to support its peacekeeping activities in Africa. The country’s small defence budget is unlikely to enable major purchases in the foreseeable future, but will likely add to its fleet of Mini-UAVs.
Civilian

Ireland is rated as having a medium likelihood of utilising UAVs in civilian applications, with particular focus on coastguard applications.

Italy

Military

Italy has gained considerable experience in the use of military UAVs in Iraq and is expected to make considerably purchases in the future across all segments, with the exception of HALE UAVs.

Civilian

Italy is rated as a strong opportunity for using UAVs in civilian applications, particularly for maritime border security, Fire Fighting, Earth Observation and Remote Sensing missions. Finmeccanica’s Sky-Y UAS is targeted specifically at the civilian market.
**Latvia**

*Military*

Latvia only has a small military budget, and like its fellow Baltic countries is only expected to procure mini-UAVs in the medium-term.

![Latvia UAV Procurement, 2008-2017](image)

*Civilian*

Latvia is likely to employ non-Military UAVs for border security enforcement at some point in the future.

**Lithuania**

*Military*

Lithuania is only expected to make small investments in military UAVs, with the acquisition of larger Mini-UAV systems expected in the medium-term.

![Lithuania UAV Procurement, 2008-2017](image)
**Civilian**

Lithuania is likely to employ UAVs to support its border security efforts.

**The Netherlands**

**Military**

The Netherlands is expected to make wide-ranging procurements of UAVs for military applications, and like several other European countries is following a bottom-up strategy. Initially, The Netherlands is buying a number of Mini-UAVs (some of which will be ~5kg and some ~30kg) over 2008-2009 and then procuring TUAV and MALE UAV systems.

The Netherlands is looking to UAVs to replace some of its aging aircraft used in the Maritime Patrol role.

**Civilian**

The Netherlands is rated as having a strong chance of using UAVs in civilian applications, particularly in the Energy Sector and Coastguard missions.

**Poland**

**Military**

Poland has become highly active on operations in partnership with NATO and has acquired a number of Mini-UAVs to support ongoing operations. As part of wide ranging modernisation plans, Poland is expected to buy a number of Tactical UAVs and a small number of MALE UAVs in the long-term.
Poland is seen as likely to employ UAVs in border security missions, but could also possibly use the systems in Law Enforcement, Coastguard, Fire Fighting and in the Energy sector.

**Portugal**

*Military*

Portugal has little experience to date in the use of UAVs for military activities, but is expected to make relatively significant moves into this area. Whilst the main focus will likely be in the use of Mini-UAVs, TUAVs and VTOL UAVs are expected to be procured, the latter of which is expected to be in Naval applications.

Portugal is likely to utilise UAVs to assist in tackling Forest Fires.
Romania

Military
Out of the new Member states of the European Union, and those that have joined NATO, Romania is probably the most advanced and experienced in its use of UAVs. Romania has been using Shadow TUAVs for a considerable period of time, and is expected to make procurements in the TUAV and Mini-UAV sector.

Civilian
Romania is rated as a low opportunity for the use of UAVs in civilian applications.

Slovakia

Military
Slovakia has limited budget available for the military, and is therefore expected to centre its requirements through procurement of Mini-UAVs. The requirement is limited.
Civilian
Slovakia is rated as a low opportunity for the use of civilian UAVs.

Slovenia
Military
Slovenia is making significant advances in its military modernisation plans, and it is expected that as part of its soldier modernisation plans, mini-UAV capabilities will be sought and acquired in the short-term. Budget restrictions are likely to mean Slovenia is unable to purchase more expensive systems.

Civilian
Slovenia is rated as a low opportunity for the use of civilian UAVs.
Spain

*Military*

Spain has proven to be a relative latecomer to the use of UAVs in the military. The military is making significant strides towards gaining experience and has ordered a number of TUAV systems. Spain is also expected to buy significant numbers of Mini-UAVs, but most interestingly will use VTOL UAVs in Naval applications and also procure MALE UAVs, potentially alongside France.

![Spain UAV Procurement, 2008-2017](image)

**Civilian**

Spain holds a strong potential for the use of civilian UAVs, with particular focus in the following areas: Law Enforcement, Coastguard, Fire Fighting as well as other applications such as in energy sector and border patrol.

Sweden

*Military*

Sweden has made significant progress in its use of UAVs and is expected to be one of the major European markets. The country has gained significant experience through its use of Sperwer TUAVs from the 1990s, and has now begun a procurement strategy to expand its inventory of UAVs, which it began through procurement of a small number of Skylark Mini-UAVs from Israel's Elbit Systems.

Recent procurement plans have all been focused on attaining capabilities for the 2008 rotation of the EU Battlegroup, in which Sweden was acting as the framework nation.
Civilian

Sweden has been making significant progress in the integration of UAVs in civilian airspace, and it is notable that in the countries largely un-populated north has allowed routine flights of UAVs at the North European Aerospace Test range.

Sweden may not have as pressing needs for using civilian UAVs, but is still rated as a good potential market for the systems, with particular interest in assistance to Fire Fighting.

United Kingdom

Military

The United Kingdom has proven to be one of the largest markets for UAVs in Europe, with procurement of a significant number of UAVs, largely in sync with major deployments on operations. As such, the UK has usually required on urgent operational requirements to provide a UAV capability, and has used this procurement route for its Desert Hawk Mini-UAV, its Hermes 450 TUAV and its Predator MALE systems. The UK has also recently procured a small ducted-fan VTOL UAV for use on operations, known as the MAV. In the past the UK has used a number of different systems, including the Phoenix TUAV, as well as testing the Scan Eagle Mini-UAV from naval vessels.

The UK is expected to continue its use of UAVs, which is further driven by the emergence of a parliamentary report encouraging greater and wider adoption of Unmanned Systems by the Ministry of Defence.
The main programme of interest is the Army’s Watchkeeper programme, under which around 58 air platforms will be procured, along with ground vehicles, stations and other elements. In the short-term, the UK will procure Predator systems to replace airframes lost on operations, and for this purpose has raised a potential sale of 10 systems with the US Defence and Security Co-operation Agency, should more replacements be needed due to attrition.

It is unlikely that the UK will invest in a HALE UAV, but both the Army and the Navy are expected to procure VTOL aircraft in the future.

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**Civilian**

The UK is pioneering the use of UAVs in civilian applications, but due to restrictions imposed by regulators on the use of UAVs in non-restricted airspace, it is instead seeing industry taking a role of educating potential end-users in the utility of UAVs through a number of different partnerships, such as the South Coast Partnership, through which BAE Systems provides the use of a UAV system, but there is no procurement. However, a number of non-military organisations have been actively looking at the potential provided by UAVs; Surrey Police conducted a study in their use, Merseyside Police procured some remotely-piloted systems and West Mercia Police have utilised lighter-than-air systems for surveillance.

Furthermore, the ASTRAEA programme has allowed the UK to tackle the use of UAVs in civilian airspace in a practical manner.

The UK is rated as having a high likelihood of using civilian UAVs in a wide range of applications.
1.2. **Strengths and Weaknesses of Europe**

There is value in diversity, but not when this leads to the dilution of scarce resources.

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<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>• Strong technology base</td>
<td>• Absence of regulations covering airworthiness, ATM and RF spectrum allocation</td>
</tr>
<tr>
<td>• Strong industrial/manufacturing and systems integration base</td>
<td>• Un-coordinated and fragmented approach (industry and end-users) has led to the emergence and proliferation of a wide variety of consortia and groups working in similar, often overlapping areas, leading to duplication of effort and the potential for divergence rather than convergence of approach</td>
</tr>
<tr>
<td>• Payloads and avionics expertise</td>
<td>• Neglect of civil and commercial markets (even more than military)</td>
</tr>
<tr>
<td>• Growing UAV experience in military sector</td>
<td>o Industry under-funding R&amp;D</td>
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<tr>
<td>• Groups which have come together to solve problems and develop the engineering and initial frameworks which will permit UAVs to “file and fly”</td>
<td>o Little government support</td>
</tr>
<tr>
<td>• Diverse industrial landscape which exists in a strongly competitive environment</td>
<td>• Late start (suppliers) (behind USA and Israel) and late adopters (demand)</td>
</tr>
<tr>
<td>• European aerospace companies already have well-established access to export markets</td>
<td>• Poor export record, both within Europe itself and especially, outside platforms. Europe has been slow to catch up on the domestic design, development and production of platforms across the range</td>
</tr>
<tr>
<td>• Large and enthusiastic home market, with plenty of room for expansion into the 2nd and 3rd tiers (E. Europe and smaller countries, as ‘force multiplier’ in military sector)</td>
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**1.2.1. Strengths**

The European Union includes some of the world’s most technologically advanced industrial countries. It is also home to some of the world’s leading multinational aerospace manufacturing and systems integration companies, as well as to a host of smaller high-tech enterprises and research institutes. Together, these organisations are still able to field the complete range of skills and resources required to conceive, design, build, test and market some of the most sophisticated technical systems available.
With a robust and enduring demand for leading-edge technologies in both the civilian and defence sectors, Europe provides a healthy domestic market for its own aerospace manufacturers and systems suppliers. These also continue to compete successfully with foreign rivals, not only on home turf but in a well-established international market as well.

Europe is therefore eminently capable of producing the full range of UAVs, from the smallest to the largest platforms, along with their ancillary equipment and systems. There is now an established and maturing market for these in the defence arena among many European States, and there exists the potential for significant export sales to Europe’s well-established trading partners. That UAS deliver critical advantages has now become accepted doctrine with European armed forces, and this has pointed the way towards the civil security and commercial fields.

In the civilian and commercial sector, there is significant, if patchy, interest in exploring how to use UAS in an already bewildering variety of roles. In some their function is seen as complementary to existing systems, in others they may replace present technology altogether. There is also a growing recognition that they will eventually be used in ways as yet unthought of, in much the same way as the “home computer” of the 1980s, or the mobile phone, whose functions have expanded dramatically since its early days as a simple (but barely portable) communications device. But adverse conditions have delayed take-off in the civilian sector. Here it remains a hostage to fortune, grounded by the absence of the requisite technology (essentially a reliable collision avoidance system coupled with an acute shortage of radio frequency bandwidth) together with the associated regulatory frameworks. Until these vital missing elements are in place, UAVs will continue to be unable to fly unencumbered in controlled airspace.

In order to remove this major road-block, a variety of European bodies, working groups and consortia are actively working on developing technologies and legislative guidelines which will eventually lead to the creation of the required engineering and legal outputs. At present progress, though slow and often apparently muddled, compares favourably with that being achieved in North America.
A number of Europe’s major aerospace companies have acquired a pan-European, not to say international footprint. And with the increasing complexity of some of the larger aerospace projects it has not been uncommon for a group of suppliers, even rivals, to come together as partners in consortia in order to meet a particular requirement. This strategy has now become well-established and largely successful practice that has proved its worth over many decades – Concorde, Airbus, Tornado, Eurofighter, Galileo – a catalogue of world-class projects.

European concerns have also formed joint ventures and other alliances with companies from elsewhere, allowing the transfer of technology as well as experience and know-how. In the UAV sector this applies particularly to relationships with the United States and Israel. ‘Euro Hawk’ and ‘Watchkeeper’ are just two high-profile examples of joint UAS projects.

Such occasional strategic co-operation between often diverse organisations can provide synergy and flexibility, which in turn can give the European aerospace business a distinct advantage at the global level. There have been few signs of such collaborative efforts having diminished the otherwise healthy climate of competition which exists both at home and abroad.

Collaboration with non-Europe suppliers has, to date, not caused critical problems of disruption or delay, but the possibility always exists as the political and competitive environment is subject to constant change, sometimes sudden and unexpected. The importance of maintaining the full panoply of skills, experience and manufacturing capability within Europe should therefore continue to be regarded as essential.

1.2.2. Weaknesses
Europe suffers from the almost complete absence of what is necessary to allow any but the smallest UAVs to operate routinely in its own airspace. This has been the source of immense frustration to manufacturers and potential end-users alike, and has led even to acrimonious accusations of foot dragging directed at the regulatory authorities. These have – quite rightly – emphasised the supreme need for caution and an organised approach in order to
guarantee the required level of safety as a new, disruptive element is introduced into the aerial environment.

Shortcomings fall into two categories: engineering and legislative. Essentially this boils down to the desperate need (from the industry point of view) for a viable sense and avoid (S&A) system suitable for UAS and the development, dissemination and implementation of a coherent, unified set of rules governing the airworthiness certification of UAS as well as their smooth integration with existing and future air traffic in controlled airspace.

In addition to these airframe-related problems there is the issue of acquiring secure command and control communication, as well as those associated with payload data transfer links. Europe’s already crowded skies are matched by its equally congested radio frequency (RF) spectrum. There are at present no frequencies allocated for the use of UAS at either a national or Europe-wide level, and this problem is not officially due to be addressed until the ITU World Radiocommunication Conference, “WRC-11”, in 2011.

At present therefore, in many countries where stringent flight rules apply, not only is it often necessary to obtain an ad hoc permit to Fly or an ‘Exemption’ – with associated NOTAMS, etc. – in order to get airborne, but it is then also essential to secure – from an entirely different Authority – the use of suitable RF bandwidth. Permissions and access in both domains are granted on demand, though in the latter case RF availability cannot always be guaranteed, and in any case it always takes time to obtain the necessary clearances. ‘File and fly’ is rarely an option outside segregated airspace.

The scale and complexity of these issues is reflected in the number and diversity of working groups that have assembled in order to address various aspects of the problem. This multiplicity of approach has produced a certain amount of duplication of effort and a diffusion of scarce resources. Resources have been scarce partly owing to an almost chronic shortage of adequate funding to support this essential groundwork. Although funding has at various times been available; from industry or academic institutions, from central and regional governments, as well as from the European Commission and other European bodies, it has too often been insufficient to support the scale of
effort required and it has tended to be sporadic, leading to uncertainty and the inability to plan ahead over the longer term.

This situation has led to some highly-skilled and experienced individuals working on a voluntary basis or in their own time, ‘for the cause’. It has often been difficult to devote the amount of time necessary to untangle this massive engineering and legislative ‘cat’s cradle’ because many of those involved have been unable to get way from their full-time jobs. Apart from the shortage of funding support the process has also suffered from the lack of clear, central leadership which could have provided a more co-ordinated distribution and allocation of tasks.

Whilst a number of European countries are vigorously engaged in working on solutions to the above, both domestically within their own Civil Aviation and Certification Authorities as well as part of the various international Working Groups, others have either adopted a passive ‘wait and see’ policy, or have no policy whatsoever, on the grounds that there is – at the moment – no local requirement. As a result some EU Member States are at very different stages on the road towards integrating UAVs into controlled airspace, making it difficult to move forward in a co-ordinated way on a broad front.

Those countries with a more muted approach tend, of course, to be those without a developed aerospace industry – on the supply side, or a lobby of potential customers and end users driving demand and the applying pressure on the authorities open up airspace for UAVs. It is also evident that, at a time when resources everywhere are limited, some States consider that their priorities lie elsewhere, and there are still many outside the UAV community who are simply unaware of their potential outside their military applications.

Even in those Member States with a strong aerospace industry and/or ‘UAV-aware’ potential customers, the emphasis has remained very much on the development and production of military UAS designed to meet a continuing healthy demand. This continues to be driven by the pressing needs of those countries with troops on operations in the field as well as by longer-term changes in doctrine within modernising armed forces. The defence sector therefore remains the largest market for UAS, and the uncertainties
associated with the timing of opportunities opening up in the civilian sector have meant that the latter has been largely neglected and starved of resources: ideas and investment alike. And, with some notable exceptions, there has been little government encouragement or support either.

Europe’s aerospace industry is the product of its past in the sense that leading EU Member States each have their own, nationally based, aerospace manufacturing base, and these have traditionally been in competition with one another. The ability to produce complex (especially military) systems is seen as vital to individual States’ national interest. Whilst European organisations have been able to collaborate successfully on large projects, it also means that – when engaging with the larger, global market – there is bound to be a certain amount of duplication and redundancy. Where UAS are concerned this has meant that – where there is work being done on UAS development – it can be fragmented and un-coordinated, resulting in a diffusion and dilution of resources as well as widespread duplication of effort and re-work.

Even in the military sphere, Europe was slow to recognise the advantages provided by UAVs. For European forces, these first cut their teeth in the Balkans and although they have since proved their worth on counter-insurgency operations in Iraq and Afghanistan, many European armed forces have still seemed reluctant to adopt UAS as part of their order of battle. So Europe has never really caught up with the United States or Israel, which continue to lead the way and to dominate the market. European nations are now busy purchasing both American and Israeli platforms, some overtly as an interim measure, while they develop their own designs, presumably as potential competitors, though somewhat late in the day. This slow start has also meant that a potentially massive export market has so far eluded European suppliers. Meanwhile, what could have been lucrative export markets have either been working on producing their own systems or have formed strategic partnerships, notably with Israeli companies, such as IAI or Elbit, in order to develop a domestic manufacturing base. There is therefore a real possibility that some late starters, especially in East Asia, will be able to catch up and perhaps overtake Europe at least in certain segments of the market. South Korea, for example is devoting considerable resources to
developing UAS, and of course, Japan has already long embraced the technology for civilian use.

There has been a suggestion that Europe abandon altogether the idea of producing platforms and concentrate instead on payloads and systems. Whilst it can be argued that it is a good idea to play to one’s strengths, this is not a strategy which has received widespread acclaim as a serious proposal within the European aerospace community, or indeed elsewhere.

1.2.3. Dependence on non-European Countries

As we have seen, although Europe has so far largely missed the boat where exports of UAS technologies are concerned, it has on the other hand proved to be a fertile hunting ground for foreign suppliers. Most of these, based predominantly in either the United States or in Israel, have been able – in the absence or weakness of locally-produced alternatives – to establish a well-entrenched presence in the European market. In the recent past, the market has been characterised by a series of urgent procurements, required to meet the needs of a significantly different battlespace than was envisaged when NATO was formed. The shift has famously been away from more-or-less evenly matched armed forces facing one another on a ‘conventional’ European battlefield. Nowadays deployments are usually far from their European bases and tend to take the form of asymmetric counter-insurgency operations. UAVs have proved themselves a valuable asset in this kind of environment, where ambush is one of the enemy’s most frequently used tactics. Once again, the Israelis and US forces were among the first to use UAS for situational awareness and force protection in this context. When European units found themselves in Iraq and in Afghanistan for example, often alongside American colleagues, they soon observed the very real advantages that such equipment could offer. Rather than waiting for a traditional supplier ‘back home’ to design, build, test and deliver a reliable system, commanders in the field demanded systems – now – that had already proved themselves. In practical terms this usually meant American or Israeli platforms. And there is a danger that history could repeat itself in the civilian sector.
Meanwhile, the largest European UAS procurement deal, the British ‘Watchkeeper’ programme, is based on the Hermes 450 platform, originally designed by Israel’s Elbit Systems. It would seem at first glance intriguing that the European aerospace industry was unable to design ‘in house’ and field a comparable system. It is in fact an indication of the time it has taken for UAS to have at last burst upon the scene in Europe, and of how slow the major European suppliers have been on the uptake.

There is some truth in the declaration that the platform is in fact the least complex component of a system, and that the Europeans’ strength lies in components manufacture and systems integration. But the platform is of course the most overt part of a system and, effectively, its ‘brand’. As such it does have significance beyond the complexity of its engineering.

For the time being Watchkeeper should therefore also be seen as an opportunity to acquire expertise and the transfer of technologies which can promote the development of a European UAS industry in the future. The same can be applied to ‘Euro Hawk’. The future ‘Euro Hawk’ HALE system is based upon the American ‘Global Hawk’ airframe, built by Northrop Grumman.

Germany’s EMT is almost unique in Europe for having been able to sell its small and mini-UAS (S/MUAS) to not only to the Bundeswehr but also to export it to the Netherlands, for its Armed Forces. Almost all other European armed forces – those that have bought S/MUAS for operational use – have gone for US or Israeli equipment if they haven’t bought locally (such as the DRAC, made in France by EADS). The reason given for this is that the requirement – often at short notice – has been for tried-and-tested kit that already has an established reputation in the field, in preference to a home-made system that has yet to win its spurs.

Europe has had more success in the mid-range and Tactical segment (TUAV) with legacy machines such as the UK’s Phoenix – now retired – and Sperwer, which have been around for some time. But these machines have done little to establish a good reputation for European UAS design. The Italian ‘Falco’ shows promise but has yet to enter active service with European forces. Other platforms in this range are in development: BAE Systems in particular has

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emerged as a serious contender with several designs (Mantis, Taranis) in the pipeline.

EADS is also active in UAS development, including rotary airframes. Surprisingly perhaps, Europe has a strong presence in the rotary UAV segment, with Austria’s Schiebel – a relatively small company – presently leading the field with its Camcopter S-100.

The survival of a domestic, independent European UAS industry depends of course upon the continuing existence of the entire range of skills, systems expertise and technologies required to build and market the product. Without both healthy domestic and export markets this will not be sustainable.

In the longer term, the market for civilian and commercial UAS has the potential to outstrip that for military systems. It is becoming increasingly apparent that there is an urgent need to facilitate the launch of this sector, which remains stalled for the reasons examined above. In order to make this possible considerable investment will continue to be necessary before the market becomes sufficiently mature to support itself. Meanwhile, the presence of a strong high-level, guiding hand capable of co-ordinating the development of the key technologies and legislative frameworks would contribute significantly to the providing a solid basis for future European success.

1.2.4. Relevance and Feasibility of UAV Technology in Europe

Certainly within the international aerospace community it has now become widely accepted that UAS have a bright future. Unfortunately, this vision has dawned rather later in Europe than it has in North America, and Israel. Nevertheless, they are now generally recognised as a key technology for the future and widely regarded as The Next Big Thing in civil and commercial aviation.

They have already won their spurs in a military role and have become indispensable ‘kit’ in the order of battle of any modern fighting force. The civilian and commercial sector has already identified a broad range of
potential applications, while new possibilities multiply almost day-by-day. Many more will emerge in time.

But UAS will have to prove themselves against existing technologies which also continue to evolve, as well as other, alternative, emerging technologies. There is a tendency among many enthusiasts in the UAS community to advocate their use in the widest range of (mainly civilian) applications where, in fact, existing technologies would be just as adequate, efficient and/or more cost-effective. Nevertheless, there are many uses, particularly in the now familiar areas of ‘Dull, Dirty, Dangerous’ (D3), where they will genuinely be a breakthrough enabling technology, with the edge over the competition.

Demand in the defence sector remains robust, and will continue to remain so for the foreseeable future. The present climate, characterised by urgent short-term military procurements, will gradually give way to a more conventional, structured and strategic approach as urgent operational requirements (UOR) are met and emergency, interim solutions are replaced by systems tailored more specifically to the user’s actual needs.

Meanwhile however, these emergency, short-term procurements, as previously discussed – and in the absence of an alternative – have been dominated by purchases from the United States and Israel. That systems of all kinds, from hand-launched models to Predator-sized aircraft, have been purchased in such numbers by European States is a testament to their usefulness – their relevance – in the modern military armoury. European aerospace organisations are eminently capable of meeting future demand for such systems across the range. In many areas they are already doing so. Nevertheless, in terms of market share they still need to catch up with their overseas competitors, and although this may prove difficult in the military sector, the civilian field is still wide open.

A proportion of the general public are aware of UAVs since their activities in Iraq and Afghanistan have appeared widely in Europe’s media. Coverage of their potential for use in the civilian sector has been less noticeable. Where it has achieved visibility, it has tended to be related to civil security and the role of UAVs in surveillance, ‘snooping’. This has tended to have a negative
impact which, incubated in some segments of the Press with a fondness for scare-mongering stories about UAV safety: robot drones crashing in heavily populated areas, for example. This type of coverage, though rare enough, is not helping to produce awareness of the positive benefits that UAS could have. A broader knowledge outside the specialist Press of what benefits UAS are able contribute may change this.

There is a widespread perception that their safety is the over-riding preoccupation in the minds of the general public. From the professional’s point of view, safety in the air – and on the ground – is in any case the prime concern of national and international civil aviation authorities, air traffic management, and airworthiness certification establishments. As examined elsewhere, it is issues around this concern that have held back the opportunity to exploit the civilian and commercial market for unmanned aerial systems. It is also why the considerable experience accumulated from military UAS operations has not been able to contribute as much as might have been expected to the civilian side. In the military environment safety is not at the top of the agenda.

The mission critical requirement for safety in the air, at least on the technical side, is a suitable sense and avoid (S&A) mechanism. European suppliers – large and small – have the resources to be able to design and produce a practical S&A system. Whoever produces a viable apparatus will hold a vital key to opening up the civilian market. The acquisition of this technology has come to be seen as something as a grail in the UAV community, and is therefore vital to European interests.

Much of the technology is already available from European manufacturers. The challenge is in the R&D, to miniaturise low-power components and to provide a robust, integrated system suitable for all but the smallest categories of UAS. Those close to the problem are expressing confidence that a system will be available by 2015.

European technology suppliers are strong in the avionics, payloads and sensors segment, where they meet foreign competitors on equal terms. But if one is looking for a concerted strategy to face UAS competition form outside,
the European approach does appear fragmented and incoherent. In this sense it reflects the fragmented approach to the delivery of a framework of rules governing airworthiness, ATM and the allocation of RF bandwidth.

Europe has the technical ability as well as the experience to develop effective rules to allow UAVs to fly in un-segregated airspace. It also has a market, ready and willing to take advantage of the technology once it is made available.
1.3. **Fragmentation, Co-operation and Competition**

Whilst Europe is effectively a single market, it is still very much a continent made up of many separate states with very different cultures, political ideologies, natural resources, skills bases, wealth, languages, priorities and requirements. Geopolitically, as well as commercially, it is inherently diverse and fragmented.

Whilst Europe’s diversity has generally been good for commercial competition – at least within Europe itself, where UAS are concerned it is at the root of a debilitating and pernicious diffusion of effort in the development of common standards and a coherent European regulatory framework. While there have been a number of initiatives designed to examine the problem and suggest solutions, the pace of actual progress towards these has been modest, for a number of reasons.

1.3.1 **Fragmentation and co-operation between European authorities in reaching common standards and regulations**

The continent has its leading, early adopter nations, its followers, and those who either do not presently have the resources to invest in UAS-related growth or who do not regard their acquisition as a priority, either for their armed forces or in the civilian sector. EU Member States therefore have very widely differing experiences of UAV use. These vary from no apparent interest to a climate in which there is a high level awareness, experience (on the military side), and an active and aggressive thrust to remove current restraints and to open up the (civilian) market as soon as possible. Although all European States are members of Eurocontrol, for example, some appear to have no contingencies in place at a national level to accommodate the forthcoming introduction of UAS. Apart from making it very difficult to move forward together as one in the drive to reach agreement on a pan-European regulatory framework, this also effectively reduces the total size of a potential home market, which is a key factor in the successful future growth of a viable European UAS industry.

There are however encouraging signs that those States which have until now shown little interest are indeed beginning to become aware of the need to act,
and assurances have been made by previously inactive national CAAs that there are plans to examine the issue of UAS operations. Additionally, States that have not so far been involved in the development of the necessary technical or regulatory UAS processes have generally indicated a willingness to fall in with those that have.

In the absence of an overall co-ordinating mechanism with a Europe-wide scope, the work required to produce the technologies and regulations needed to enable UAS to operate un-segregated airspace has tended to evolve erratically, organically. A number of different projects: study groups, working groups and other concerned bodies have proliferated to fill perceived gaps and to address particular aspects of the problem. They have sprung from government as well as industry initiatives. Inevitably the work of these groups (which is further described, elsewhere in this document) is fragmented and has overlapped, resulting in a certain amount of duplicated effort.

Fortunately however, their efforts are evolving in an atmosphere of openness and dialogue. Some individuals are also members of more than one group at either a national, international or European level, as well as holding down a full-time job in either an industry manufacturer or one of the national authorities dealing with UAS integration. EUROCAE’s key Working Group, WG-73, for example is draws its membership principally from various European official as well as commercial bodies, but it is also includes representatives from the American FAA and RTCA’s Special Committee on UAV certification standards, SC-203, and from Israel. The JARUS group too is interested in contacts not just across Europe, but also with UAS stakeholders further afield, in Australia and South Africa. These groups form dispersed clusters of expert individuals from interested national authorities, institutions and industry from a wide variety of backgrounds. They are also in touch with military UAS colleagues at both the national (usually through members of the local CAA) as well as the NATO level.

This has often informal arrangement has facilitated the dissemination of news on developments and helps to prevent the evolution separate, divergent solutions and unnecessary duplication. Nevertheless, it has been fairly widely acknowledged that the presence of a high-level supervisory body would
definitely be useful as a means of ensuring a more organised sharing of information, the pooling of resources to eliminate duplication, and a more structured approach to the allocation of resources. The regulatory effort needed has also suffered from under-funding, and a co-ordinating or overall supervisory body would also be beneficial in channelling funds to where they are most needed, whether in the development of technical solutions or the towards the regulatory framework for ATM and UAS airworthiness certification.

Where there could be a better connection is with industry, and with the potential end-users of civilian UAS. In the United Kingdom, a partnership of leading commercial interests, academics and regional government development authorities has come together as ASTRAEA\(^1\), in order ‘to promote and enable safe, routine and unrestricted use of UAS’. Funding for the project is split equally between government and industry. Perhaps unfortunately, this initiative is unusual in Europe. It is an example of what could be accomplished elsewhere to encourage the condensation and maintenance of momentum through collaboration and co-operation between all those concerned. It provides a forum where academics in R&D, influential industry players, as well as central and regional government bodies can share information and examine what is needed to promote their interest.

In general however, Europe’s approach to solving the major issues still standing in the way of standardisation and regulatory progress remains fragmented and diffuse. It is evident that a more consolidated methodology is required in order to bring forward the achievement of concrete results.

Meanwhile, the EU Reform Treaty, in whatever form it eventually takes, will probably retain the provision for a more robust defence European policy. In October 2008, President Sarkozy’s advocacy of a European defence force received a favourable response from the UK’s Foreign Secretary. Should these events lead to real changes, these could lend further impetus to the standardisation and integration of military procurements, as well as a more prominent role for FRONTEX, the European border security agency, for

\(^1\) ASTRAEA - Autonomous Systems Technology Related Airborne Evaluation & Assessment
example. Such developments will have a positive effect on the further introduction of UAS.

1.3.2 Fragmentation, co-operation and competition in the commercial sector

Europe’s geo-political legacy of diversity and fragmentation is equally evident in the commercial sector, where there are still numerous aerospace companies of various sizes that have often retained their national identity and affiliations. However, Europe’s Tier 1, Prime contractors have also acquired a pan-European if not a completely multi-national footprint.

Europe’s aerospace organisations have traditionally existed in a diverse landscape that has helped to nurture a climate of healthy and often intense competition, both within the home market as well as globally.

Europe’s aerospace and related industries are vital to its future strategic interests. They are a significant source of revenue and a major provider of jobs to a workforce whose skills need to be retained in order to ensure continuing European independence rather than the degeneration towards a growing reliance on foreign sources of supply.

Although Europe’s aerospace manufacturers – with some notable exceptions – have not entered the market for UAS as soon as their main foreign competitors, this has not been through an inability to do so, and it is difficult to see how existence of a more consolidated European industry would have made a difference in this context. In fact, a more monolithic structure may have led to even less flexibility, an area where SMEs are particularly valuable.

The existence of competition has been essential in maintaining a viable aerospace sector in Europe and this will not change. The formation of partnerships and joint ventures as and when this is required has not perceptibly damaged this state of affairs. Mergers and acquisitions are already subject to certain controls which are designed to ensure the market remains a competitive environment.

At the moment Europe’s most significant competitors (for the purposes of this study) are the United States and Israel. Although very different in size, as nation states and as economies, they each have the advantage of a
homogeneity that is largely absent in Europe. Both possess a hi-tech industrial base, with a number of companies producing a range of UAS and their ancillaries, and these have also benefited from the advantages of healthy competition ‘both foreign and domestic’. The armed forces of the United States and the IDF were the early adopters of UAS, and this has frequently been translated into an evident competitive advantage for their suppliers when overseas military customers are urgently demanding systems that have been proven in the field. This lead has also placed them on the high ground from which to tackle the civilian market, when it goes live.

Given Europe’s industries’ acknowledged lag, where collaboration could be further encouraged is in the field of R&D. These activities could be more productive if they were co-ordinated, perhaps under the aegis of the European Commission, through the medium of a high level steering group that would act as a clearing house, sharing information and ensuring the efficient allocation of resources in this field. Activities would tend to condense around clusters of UAS-related efforts with a minimum of overlap. These clusters, located across Europe, would be potential ‘centres of gravity’, drawing together interested participants in either loose or formal associations. A possible prototype for such a focus point is ParcAberporth, the de facto UAV centre in the United Kingdom. This facility, supported by a local government initiative, has already established a widely acknowledged reputation as a centre of excellence, and has succeeded in attracting some high-profile players to what is otherwise a somewhat remote area in West Wales.

There are already in the UAV industry a number of precedents for small companies, start-ups or SMEs, forming partnerships with industry primes in order to gain access to the market. This can also benefit the larger organisation because, among other advantages, it doesn’t have to shoulder expensive R&D costs. Such a strategy can be hazardous to the smaller enterprise however, should it wish to remain independent, since the smaller fish can eventually be absorbed into the belly of the whale.

Where a new technology is involved, or there is an opportunity to bid for a large procurement, such partnerships – either between SMEs and Tier 1 contractors, or between companies of a similar size – are common practice.
This could be seen as contrary to free competition but, in the short term, a consolidated effort is needed to jump-start a serious European response to the threat of being overwhelmed by foreign UAS suppliers, who often have several years’ lead in the market. This is particularly the case in the civilian sector.

A degree of European collaboration and co-operation even between larger primes is therefore necessary in the earlier stages until parity with external competitors has been reached, or nearly so.

Collaboration will almost always be an advantage for lower tier contractors who may not otherwise have the capability for the end-to-end supply of an integrated system. It can produce a level of synergy, and a product of a quality, that would not otherwise have been achievable.

Competition will open up further within Europe’s traditional competitors as this new market begins to mature, both in the military as well as in the civil sectors, the latter rather later however, since the civilian market remains constrained by enduring safety issues arising from the lack of technical solutions and a regulatory framework, as previously described.

Intra-European competition is therefore important ingredient in maintaining the healthy diversity of enterprises present in the European market ‘gene pool’. This also includes the participation of companies from outside the region. There is also a competitive advantage in a degree of rationalisation and consolidation, in both the military as well as the civilian sectors.

On the other hand, a high level of collaboration and co-operation is absolutely essential in co-ordinating Europe’s efforts to introduce UAVs into controlled airspace. Here competition between groups may be healthy, but only where they are striving for the same goal, and such competitiveness doesn’t deprive the overall effort of vital resources, either human or financial.

These activities could be facilitated by creating a body responsible for co-ordinating existing efforts. It would provide a single, central forum or Exchange, for sharing information (e.g. via the www and in co-ordinating workshops) on European UAS developments. It would identify gaps, alert duplication and allocate resources. Although not necessarily endowed with
statutory powers it would be able to exercise a degree of influence through patronage and the appropriate distribution of funding. Many of these sharing and collaborative activities are already taking place spontaneously; the idea is not to frustrate them but to create a single ‘entrepôt’ available to all those involved: official authorities, academic institutions, government bodies and industrial and commercial interests. It would provide a ‘concentration core’ and a focus point for a more coherent European UAS movement.
1.4. **Expected Opportunities from the Suppliers' and End-users’ Point of View**

Opportunities in the domestic European defence market are set to continue well into the future across all platform types, except HALE (VHALE) and MALE. Few of the latter are expected to be acquired in Europe owing to their high unit cost and the fact that a single platform is in any case capable of providing a wealth of information collected from a large target area or ‘footprint’. The principal HALE programme in Europe, the Euro Hawk, envisages Germany's procurement of four platforms in a 50/50 joint venture between America’s Northrop Grumman and EADS, with the latter providing a new ELINT (electronic intelligence) payload component. EADS is also working on an ‘Advanced UAV’, whose modular construction will enable it to fill a variety of roles, including, presumably, MALE as well as UCAV (combat) missions. France and Spain have also expressed an interest in participating in the project, although Dassault Aviation, with Thales has also offered them its SDM design. Characteristically, both these programmes are still at an early development stage however, whereas Global Hawk is already flying operationally.

European nations will also have access to a shared resource through NATO Global Hawks (the same platform from which Euro Hawk is derived) as part of the NATO AGS (Alliance Ground Control) system.

New home markets will emerge in NATO accession countries and with the armed forces of some of the smaller European nations, which have not yet acquired UAS. Ratification of the European Reform Treaty is likely to present new opportunities, not only in the defence sector, but also in civil – particularly border – security with FRONTEX, the European frontier security agency assuming an enhanced role.

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2 SDM Système de Done MALE
Technology will continue to evolve rapidly in this market, which is still far from mature, and demand for replacements of obsolescent equipment will also continue to keep the market active.

Civilian markets will begin to open up as the pressure of demand drives more UAV flights in niche applications. It is now commonly accepted that the civilian market will eventually provide much greater opportunities than the defence sector, although individual purchases will tend to be smaller than the mass procurements commonly associated with military contracts. The civilian market, although stalled at the moment for reasons previously examined, offers opportunities across a wide range of applications.

**Potential applications for civil and commercial UAS**

As more missions are flown and flight hours accumulate under the present restricted conditions, SOPs and de facto rules governing airworthiness certification and ATM procedures will begin to emerge and increasingly will be sanctioned by the relevant authorities. The integration of UAS into the existing environment will not come suddenly as a ‘Big Bang’; it will be gradual and sequential. The pieces of the jigsaw will progressively be slotted into place, eventually forming the complete edifice.

Experience gained in civilian roles overseas (i.e. outside Europe), where airspace is less (or un-)regulated, will provide valuable experience when
developing SOPs for use in Europe. Examples of such opportunities exist in the oil and gas industry – both in exploration and in the monitoring of assets such as platforms and pipelines; emergency disaster relief in remote areas; and maritime applications over open ocean such as pollution monitoring, rescue missions, fisheries and the prevention of piracy.

Civilian and commercial manufacturers are already present and ready to provide services using UAS in a broad variety of applications (see the figure, above). However, the first area to open up is likely to be in government-related applications: civil security, law enforcement, and the emergency services. State operated systems will be easier to integrate into un-segregated airspace owing to their connection with the relevant authorities as well as the presence of existing experience and SOPs relating to manned aircraft such as Police and Rescue Services helicopters, etc. Civil security and law enforcement offer a wide range of potential applications for UAS, some of which are presently covered by manned platforms, others would be new territory for aircraft.

However, their principal function would be surveillance, and in this role they would have to prove themselves at least as good as alternative methods, often already tested as efficient and cost effective. Nevertheless short-range UAS have been trialled in a traffic-monitoring role, and it has been suggested they also be used to monitor railway networks, which have been subjected to vandalism and the theft of copper wiring. They have also been tried in a variety of surveillance scenarios, perimeter surveillance at airports and the tracking and monitoring of suspects. UAVs are quieter than conventional helicopters, causing less disturbance at low level over built-up areas, and providing stealth in tracking suspects over any terrain. The latter role will be particularly suitable to the use of nano-UAVs, which are in the process of being developed by France’s ONERA, for example, as well as by a number of academic research teams across the continent. Miniature and nano-UAVs are able to operate inside buildings, and are able to ‘perch and stare’, conserving power while continuing to provide data to their operator at a remote location. UAS would be useful in providing coverage involving crowd control: sports events, demonstrations and celebrations. Such events may involve the
temporary segregation of controlled airspace, which may permit the use of larger UAVs. This situation would certainly apply to major incidents involving the emergency services, such as a seismic or volcanic event, a major industrial accident, or even the search for survivors of an avalanche.

UAVs have already been used, and proved useful in the aftermath of natural disasters such as the Asian Tsunami and Hurricane Katrina, where they were used in damage assessment and in the hunt for survivors. In the future they could also be used as short-range relays to provide mobile communications if the existing infrastructure has been destroyed or is non-existent.

Owing to the problems associated with flying larger UAVs within the airspace of many European States, most of the above applications would involve smaller UAS, able to operate at a low level in visual line of sight (VLOS) and therefore able to do so with a minimum of involvement with ATM authorities. The need to operate at modest altitudes – generally around 120 metres (400 feet) – and in VLOS inevitably reduces a system’s effectiveness, even if it is able to remain aloft for more than the hour or so, the maximum presently achievable by systems of this size using conventional power sources.

However, opportunities in this sector may also be reduced by the employment of seconded military platforms where this is practical, at least at first.

The date of the introduction of a viable Sense and Avoid (S&A) technology and associated airworthiness certification and ATM legislation will dictate when the market as a whole is able to take off. Meanwhile, the majority of commercial opportunities will be restricted to small, short-range UAS.
The fire fighting market is weighted towards southern Europe, where small MALE and short-range UAVs are seen as potential assets in fighting forest fires. However, fire services elsewhere in Europe are also examining ways of using light UAVs at major incidents such as fires at industrial plants, especially where there is the risk of chemical contamination.
Energy companies are interested in how UAS can monitor infrastructure assets, but European airspace restrictions will hamper early development. Opportunities for companies operating overseas however are more encouraging and will provide valuable experience for later, domestic use.

Agriculture and forestry will favour light VTOL or fixed-wing UAVs flying in line of sight, with MALE UAS addressing the fisheries market. At a very different level, HALE UAS are eventually expected to replace many satellites in communication, broad casting and remote sensing. A UAV can be retrieved, upgraded and re-tasked. It can also be moved to a different location from its automated GPS-generated flight pattern at little cost. The options open to a satellite on the other hand, once launched are relatively few. It can sometimes be moved, but it has a finite fuel reserve, and its hardware cannot be modified; it is doomed to obsolescence once it has left the launch pad. There has already been interest from Japanese HDTV and 3G phone networks, and trials have successfully been conducted using Aerovironment’s Global Observer HALE UAV prototype.

In the remote sensing area applications are expected to include Aerial photography and survey photography using IR, spectral analysis and miniature SAR (synthetic aperture radar), geographical and geological surveying, digital cartography, post-disaster mapping and damage assessment. In Europe the monitoring of seismic events (earthquake and volcanic) is the subject of research in Italy, but the technology would also obviously have significant export potential, not just to other areas In the eastern Mediterranean, and the Atlantic islands but anywhere else vulnerable to such activity. The British Antarctic Survey has already used small UAVs to examine the behaviour of the changing climate and its effect on the icesheets. HALE as well as smaller UAS could be used to monitor desertification and give warning of draught in susceptible areas. Australia has employed a UAV to track the migration behaviour of cetaceans off its coast, but this environmental application could equally be used to track the migration and population densities of land animals in remote locations, as well as birds. At high altitudes VHALE UAS would provide air quality sampling and pollution
monitoring as well as meteorology: tracking cyclones and providing advance warning of floods and extreme weather conditions.

In addition to the opportunities expected in these vertical markets, a broad-based UAS support market will become a major growth area. This will cover not only leasing or chartering services but MRO, training, consulting and other specialised ancillaries.

The support and services market has already gained traction in the military domain as these components are out-sourced to the private sector, and there appears to be a trend towards an increasing reliance on this model. Contractor support has become commonplace, even in the field, near the front line, whether for maintenance work or for training military operators. In some instances, civilian personnel hired by contractors are also flying UAVs on operations, a situation which has the potential to raise some thorny ethical questions about the parameters governing what they are allowed to do.

Through-life support is become an increasing expectation as MoD’s strive for greater value for money, and this will be even more true in the civilian and commercial sector. A significant example of such an arrangement is that reached between the UK’s Cobham defence contractor and General Atomics to supply the RAF with logistics support for its Predator fleet. This is also an instance of a major European service provider, one that is not usually directly associated with the UAS industry, providing add-on services to a foreign supplier, a model that is bound to be repeated more frequently in the future in across the market as a whole.

The civilian market, although forecast to eventually outstrip military sales, will not be characterised by the large contracts typical in defence procurement. Indeed, it is expected that a large proportion of platforms will not in fact be owned by their end-users but by service providers. These businesses will either be spun out from manufacturers keen to get their products into the market, or from chartering concerns in the same way that manned aircraft, fixed-wing and rotary, are available today for aerial photography, electricity grid and pipeline monitoring, etc.
Other ancillary or support markets include training, supported by simulation technologies, which will provide for the expected demand for personnel qualified in the regulations, once these are available, as well as the technical skills necessary to operate a range of UAS.

Meanwhile, existing European legislation (EC Reg. 785/2004) requires all UAVs weighing more than 20 kilos to have adequate insurance cover. Without insurance therefore, many UAVs will never get off the ground. There is also the issue of product liability insurance for all classes of UAS.

However, although insurance cover is not, yet, a statutory requirement in all European nations for all classes of UAV, it is under any circumstances an important consideration in practical terms for all operators other than government agencies, which are self-insuring. ‘State aircraft’ (military, customs, and police) are exempt across EU – i.e. self-insured. (Note: Only specifically military aircraft however are subject to military flight rules. Others, such as Police and Customs fall under civil aviation jurisdiction for ATM purposes).

Whilst some commercial operators will be prepared to absorb the loss of a small aircraft, the liabilities which can be incurred from loss or damage caused to third parties are something that no sensible business would contemplate without adequate insurance cover. The insurance market – like everyone else – has so far had limited experience with UAS to date, but Lloyd’s of London is placing a small but steady number of risks. So far these have come principally from OEMs involved in R&D or demonstration flights rather than from commercial operators engaged in routine business. But the market will grow rapidly, providing a significant market opportunity once UAV operations begin to become more routine.
1.5. **Technology issues**

The primary technical concern for the time being is the development of a Sense and Avoid (S&A) technology adapted for use with UAS. At present the components are available but the challenge remains in the integration of the parts into a workable unit. These units will need to be light with very low power consumption, especially those for use on the smaller platforms, where weight is already a critical issue.

**Defining standards**

Even before the considerable technical challenges there is that of defining the standards required. Essentially, it is accepted that a UAS should operate at an ‘equivalent level of safety’ (referred to as ‘ELOS’) as manned aircraft flying in controlled airspace. Although this sounds simple enough, defining exactly what this means has in fact turned out to be a truly tangled skein of wool, and a major challenge to those involved, consuming both time and resources. But without exact standards it is impossible to produce useful engineering designs for the technical apparatus which has to operate precisely according to the parameters as described by these standards: deadlock!

This quid pro quo has led to a level of frustration among many of those involved. Engineers on the industry side have blamed the regulatory authorities for not producing the necessary descriptions of the standards required, while the latter have accused the engineers of not coming up with the necessary technology so they can design the legislation. This ‘Catch 22’ situation has been just one of the causes for the slow progress in integrating UAVs into controlled airspace in a way that is compatible with existing users.

**Sense and Avoid**

In order to add impetus to the process, the EDA has sponsored a project specifically dedicated to solving the S&A problem. MIDCAS, inaugurated in 2008, is a multi-national, four-year effort dedicated to tackling the issues associated with producing the standards for a MID-Air Collision Avoidance System. Work is being co-ordinated with EUROCONTROL, which presides over ATM and airworthiness certification rules and standards. The
development these is in the hands of EUROCAE’s specialist Working Group, “WG-73” (see Section 2.0, below).

The project’s participants involve government representatives from Sweden, with France, Germany, Italy and Spain, as well as a 14-member industry consortium. An initial proposal from the latter is expected in January 2009. This will be followed by a 3 ½ to four-year period in which to produce a flying technology demonstrator ‘that will enable the use of UAV Systems in non-segregated airspace’. The present goal is that the technology will be available – although not as a commercial product – from late 2012 or early 2013.

Simulation
The introduction of UAS into controlled airspace is being greatly facilitated through the use of simulation. Testing equipment designs and various ATM scenarios in a synthetic environment is made possible without any danger to air traffic or people on the ground.

The UK’s ASTRAEA consortium, for example, has recently tested in cyber-airspace an S&A system developed by its members. During the exercise the virtual UAV was presented with different circumstances and problems, which it had to cope with.

Simulation plays a major role in training the pilots of both manned and unmanned aircraft. As the market for the latter expands, demand for dedicated simulation software, and complete systems will do so in proportion – in the military market, but especially in the civilian sector.

Human Interface – GCS
At the moment UAS ground control stations (GCS), owing partly to their UAV’s mission profile, different pedigrees, range of manufacturers and other factors, come in a wide range of designs. This is also partly because the technology is still comparatively new, and many systems have been rushed into production in a manner that is not characteristic of the aerospace sector. Indeed some successful UAVs have not come from traditionally aeronautical manufacturers

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3 EUROCAE – European Organisation for Civil Aviation Equipment
4 ‘MIDCAS and EDA. Proposed Strategic Objectives 2012’ - Régis Brigaud
at all. Nevertheless, in the automotive industry, more than 100 years ago, it took very few years before a standard driver interface evolved and was quickly adopted as the standard. Most vehicles with four wheels or more, and of whatever size, have the same basic controls, wherever in the world potential drivers find themselves.

**Manned Motor Vehicles 1908–2008**

1908 – Ford Model T

2008 – Jaguar XF 2.7d V6

Same, standard controls found on most wheeled vehicles, whether passenger or heavy freight-carrying.

- Steering wheel: Directional control
- Brake (foot + hand): Velocity control
- Accelerator: Velocity control
- Gear shift (man+clutch/auto.): Power management

Even the basic controls of a manned aircraft are recognisable to any pilot since the early days of flight. This is far from yet being so in the case of UAS, where controls can vary from a laptop keyboard to a simulated aircraft cockpit, and the use of computer game controllers is becoming increasingly popular, at least on the smaller types. Given the demographic and inclination of many of the current generation of 'pilots’, such a trend is a serious option.

Already, some manufacturers are offering common GCS (CGCS) equipment across a range of platforms. Interoperability provides the advantage not only of being able to fly more than one type of platform from a single GCS, it also means that a single operator would be proficient on a variety of platforms with a minimum of additional training. At a time when military UAS operators are in high demand this can save a great deal of time in getting airborne in a variety of mission roles. Reducing the amount of (re-)training needed also represents a very substantial saving in costs as well as time. Again, this would have a significant impact in both the military as well as the civilian sector.
NATO STANAG 4586 is the military standard that is becoming increasingly accepted as the basis for GCS design, guaranteeing a recognised level of specification as well as interoperability. It has also been of some assistance in developing common standards for civilian GCS, but civil aviation people are quick to emphasise that the usefulness of military specifications is limited because of the low emphasis on safety, which is the prime concern in civilian aviation.

**Miniaturisation**

UAS are a rapidly evolving technology which is as yet far from maturity. One aspect of their evolution is a strong trend towards miniaturisation. Weight has always been a factor in aircraft, and one of the key selling points for UAS has been that they dispense with the weight of the aircrew (these still exist, of course, but remain earthbound). Nevertheless, this is all too often a red herring, since equipment required precisely owing to the absence of a physical human presence is actually heavier than a human crew. Miniaturisation is however – literally – eroding the size of this problem, with transponders, SAR, avionics, communications links, cameras, and other essential components becoming ever-smaller and lighter while their functionality, if anything, continues to improve. The same applies to payloads. Sensors are becoming smaller, more versatile and multi-functional.

Miniaturisation – together with improved engine efficiency – also mean that smaller UAVs are now becoming capable of carrying out tasks previously only possible to their larger brethren. Small but sophisticated payloads can deliver high-quality data over longer periods above the target. In military terms this potentially means that Small and Mini-UAVs are acquiring the capability that only tactical (TUAV) systems were able to provide until recently, and at less cost, and so forth – to a certain extent – up the size and cost range. These benefits will apply equally in the civilian market, with the additional advantage that smaller UAVs are less susceptible to official flight and certification restrictions.

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5 SAR - Synthetic Aperture Radar
Fuel and power plant developments

Increased performance from better fuel efficiency and improved power-plant is also changing rapidly. The need to carry less fuel or a lighter battery means an increase in payload. A more efficient engine delivers longer loiter time over a platform’s designated target area.

Presently, most UAVs use conventional power sources and engines. The smaller platforms often use electric engines (which are also very quiet), while the larger airframes use hydrocarbon fuels, including diesel.

However, alternatives are actively being explored and tested: fuel cells have already been successfully used aboard even modest-sized platforms, with dramatic results. Fuel cells have until recently been heavy, providing a low power-to-weight ratio. However, demand is driving rapid evolution of the technology. In 2008, Aerovironment’s ‘Puma’ hand launched MUAV achieved a flight time of nine hours using a fuel-cell/battery hybrid engine. This represents a significant improvement over the 2-3 hours previously achievable by the same, conventionally-powered platform. The same firm’s larger (170-foot wingspan) Global Observer HALE project is designed to remain aloft for a week using hydrogen fuel and carrying a 454 kilo payload at an operational altitude of 65,000 feet, which takes it above the weather and commercial air traffic. A prototype has already been tested over Japan as a relay platform for HDTV and 3G phone networks, a function conventionally performed by a satellite.

In Europe, Boeing, at its research facility in Spain, has flown a prototype fuel-cell powered glider assisted by batteries.

Solar power – from panels built into the airframe – has enabled QinetiQ’s Zephyr HALE UAV, for example, to make record-breaking flight endurance times at altitudes over 60,000 feet. The aircraft uses solar power to drive its engines and charge its batteries so that it can also fly at function at night on stored power. Zephyr is being used in the United States by DARPA to explore VHALE technologies as part of its ‘Vulture’ programme; a rare example of a European UAV being used in such a state-of-the-art role.
Aside from the longer flight times potentially achievable by fuel cell and solar-powered UAVs, the cost and availability of fossil fuels is providing an additional driving force towards the development of efficient, alternative fuels and power plants.

While new and advanced technology can deliver improvements in performance, the maturing of the UAS market is increasing the availability of more affordable COTS (Commercial Off The Shelf) components. This can reduce the development time of systems: platforms, payloads and ancillary systems. It is also good news for SME suppliers on modest budgets.

**Advanced Materials and Aerodynamics**

Developments in composites and other advanced materials are making airframes lighter, enabling heavier payloads and greater fuel capacity.

Research is exploring the advantages of advanced, even morphing, aerodynamics which can maximise efficiency for different altitudes, speeds, UAV sizes and mission profiles. At the small and nano-end of the scale, experimental devices are being tested, including ornithopters which mimic the flight of insects and birds. Research is being carried out into the possibility of using synthetic biological components.

As costs come down, advances in photovoltaic (PV) technologies such as thin film solar coatings may permit even small electrically-powered drones to supplement/recharge their battery power both in flight, or while at rest.

A very significant proportion of the most innovative ideas and technologies are coming from small, specialised research projects. Many of these are located or originate in university research departments, and some are spinning out into small (often just a few, highly-motivated individuals), high-tech enterprises, much as they have been doing in the bio-tech industries since the late 1980s.
1.6. The Future Role of SMEs

Small & Medium Enterprises (SMEs) are a vigorous and vital segment of the European UAS community. They are already active as second, third and even fourth tier companies in a market that offers enormous potential opportunities once the civilian sector opens up.

SMEs combine originality and agility with low R&D overheads, allowing them to enter the market in niche areas or with low-cost systems. They therefore tend to occupy the S/MUAS (military) or L-UAS (civilian) segment more than others, and this is precisely the area that it is anticipated will form the most active portion of the market in its early stages.

<table>
<thead>
<tr>
<th>Tier 1</th>
<th>Systems integrators</th>
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<tbody>
<tr>
<td>Tier 2</td>
<td>Manufacturers of main equipment (platforms)</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Sub-system manufacturers</td>
</tr>
<tr>
<td>Tier 4</td>
<td>Components producers</td>
</tr>
</tbody>
</table>

However, they have do not always have direct access to the defence markets that are effectively the ‘only game in town’ for now, nor – if they do and without the support of one of the major suppliers that will already have an established relationship with the relevant MoD – are they usually able to meet the size of the demand that the large military contract represents.

They are however a major source of innovation, in ideas as well as technologies. With their dynamism and their reputation for originality and innovation, their continued survival is crucial and needs to be fostered. Whilst it is the generally accepted doctrine to allow market forces to operate with a minimum of official interference, it is also important to protect a threatened species if it should become vulnerable.

SMEs are unlikely to be successful as manufacturers and suppliers of complete systems, they are more likely to play a significant role as part of the
supply chain, providing specialist components and payloads as part of a UAS package being assembled by a systems integrator. There will of course be exceptions, where a small manufacturer may build a product which captures a part of the market and achieves ‘critical mass’, allowing it to build on its own success. Some comparisons can be drawn between the present activities of UAS-related SMEs and the ‘home computer’ market of the early 1980s. Apple Computer famously started in a garage, as did several other firms in the personal computer (PC) market that are now household names. And this was despite the established presence in the marketplace of industry ‘giants’ such as IBM, NCR, and Honeywell.

SMEs will frequently have recourse to venture capital or private equity firms in order to invest for rapid growth, or to fund their R&D programme over an important period while bringing a product to market, for example. In order to gain access to the lucrative government contract market they may also form a partnership or other close association with a Preferred Contractor, usually one of the ‘Tier One’ industry primes. In either case this can effectively render them into the hands of others who may have little interest in their continuing, independent survival. This may not be a negative outcome, indeed it is often a keystone of a SMEs business model to be swallowed by one of the big fish.

SME numbers are bound to dwindle, as the market matures, takes its toll, and as mergers and acquisitions change the landscape. However, in the event that such developments lead to the widespread smothering of the smaller enterprises – even if those being ‘swallowed’ go willingly, it could eventually erode the present lively climate of innovation within this segment of the UAS industry. Nor does a market dominated by an increasingly small group of very large organisations favour continuing healthy competition within the European market. A balance needs to be maintained, therefore, between free market activity and the enduring need for an independent base of small, dynamic, start-up companies and medium-sized suppliers.

While their partnerships with Tiers One and Two organisations grant SMEs access to major market opportunities, there are also clear advantages in this arrangement from the larger companies’ point of view. It can be a very cost-effective strategy to partner with an SME. In certain areas for example, the
demand for UAS may not yet have scaled up to a level that justifies major R&D investment. Outsourcing for innovative technologies therefore becomes a way of significantly extending their technology portfolio, either in the current military or in the emerging civilian sectors, on the back of a modest outlay. Some of the major UAV suppliers have joined up with SMEs in this way – among them Boeing, EADS, Elbit Finmeccanica, IAI, and SAGEM.

Their initial experience of SMEs in the military market is significant since it may provide them with their first exposure to an end-users’ perception of their product. Once demand in the civilian market starts to grow, those enterprises with an established track record in the military sector 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 First Tier companies, and can often respond quicker than primes to urgent demand. However, the focus of most SMEs will not continue to be entirely on the military segment once the civilian side has opened up. European companies such as Germany’s EMT have been successful in addressing military demands for small UAS, but the opportunities for medium-sized companies usually rely on different dynamics in the civilian sector: a larger number of separate customers, smaller sales to these, and the use COTS components. This will require a significant degree of adaptability from those already fortunate in having an established relationship with military sales.

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 high sales volumes instead of modest orders for high-value units, with the former model more difficult to achieve in the civilian sector than in the military market. In this context, industry business strategy, as well as government-sponsored support and regulation are expected to play an important part in affecting the degree
of success achievable by European 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. Tiers One and Two products. In addition, the prospect of competing with well-funded Western European Tiers One and Two 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 newer EU Member 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.

Where SMEs will face foreign competition is from their established opposite numbers in North America (Canada is keen to develop its capabilities, especially with an eye on the future of the civilian sector) and from Israel. UAS manufacturers further afield, especially in the Asia Pacific area are also beginning to assert themselves, and this is expected to have an impact beyond the region in the future. In the short term, SMEs are unlikely to be placed under pressure from players such as China, Japan or South Korea. All three countries have already taken some initial steps towards military and civil UAV production, and many SMEs are involved in this 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. Otherwise, market growth
dynamics appear to be very similar to those seen in Europe: Universities / Research Institutes are designing prototypes, and small enterprises rely on integrators (such as KAI) to gain initial experience in the UAV market. In Japan, the civil UAV market for some applications (especially agriculture) is already well established, and the military segment is catching up. Japan, however, does not permit the export of military technology, and even Japanese civil UAV manufacturers find it very hard to export their products since they are considered as having a 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. Other notable participants in UAS development and production – particular for the smaller platform types – are Australia, which has an active UAV industry as well a potentially substantial civil market, and Singapore.

**Investment**

Securing future investment in R&D is another challenge faced by SME UAV start-ups in particular. As previously discussed, innovative SME technologies often emerge either from University research projects, usually directly or indirectly funded by Government, or from initiatives created by small groups of expert individuals keen to exploit a specific product or idea, but often with little funding of their own to bring it to fruition, once out on their own.

In a segment where the pace of technological advance is swift, deep pockets, which will guarantee continuing R&D funding, can be crucial in giving SMEs the ability to compete in the European as well as the wider market. This funding is all-too-often the key, but for fledgling UAS concerns in the early stages of growth, as with so many others elsewhere, the advent of the Global Economic Downturn could not have come at a worse time. In a period of financial constraint and cautious investment that is set to last for at least the medium term, it is becoming harder to find investors from the commercial capital markets in what is still seen as risky, uncharted territory.
Competition will also dictate the future participation of SMEs in the European market. Israeli and US technologies are already a cornerstone of many European platforms, and both countries have stable industries capable of competing on both fronts: airframe production and systems integration. And there is also the potential future appearance of competitive systems becoming available from the Asia Pacific region. Again, institutional action could be crucial in ensuring that SMEs are able to secure a competitive position in the European market, although it may indeed be difficult to reconcile any such action with a free trade ethos.

The degree of European Government participation, at either the national or EC level, is not restricted to that covered above. It does in fact have a more important 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 official 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 yet entirely convinced of the beneficial applications of UAVs in general.\(^6\) Potential end-users are also concerned about the impact that flight restrictions and certification issues will have on the market and, rather than seeking an innovative UAS system, may go instead for a solution that has already proved itself. There is therefore an urgent need for further demonstrations of 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 will become more accepted as a viable alternative to those systems they are expected eventually to replace: manned platforms, fixed surveillance assets, satellites, etc. Major industry participants also have concerns that, at this point, negative coverage of military UAV activities could damage 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.

Many of the funds currently available for UAV R&D are directed to integrators (Tier One) rather than to SMEs. Channelling investments or other support to lower tier companies is likely to help fuel the development of innovative solutions and also to initiate the emergence and growth of a solid European UAS industrial base in the SME segment. Unfortunately, the SMEs themselves are responsible for this as many of them spend far too much effort on the development of new platforms rather than bringing their expert knowledge to bear in areas where it would be more useful; sensors, avionics, communications, software, materials, GCS and other ancillaries, including services.

The most effective way of ensuring future SME participation in the European UAV market is therefore the presence of a degree of government and EC support, albeit one that will ensure that funds will be spent on technologies rather than platform (airframe) development. It requires a significant effort from decision makers to educate industry and foster the idea of UAV applications among both potential producers – on the supply side – as well as among 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 committing to major further investment. Once regulation is in place and understood SMEs are likely to engage with 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 relevant European authorities.

Within the industry there is still uncertainty concerning the predominant business model that SMEs should adopt in order best to exploit future opportunities in the European UAV market\(^7\). Airframe manufacture, sensors,

\(^7\) European Civil UAV Market – UAVNET / Frost & Sullivan; 2007.
payloads and sub-systems innovation and development, civilian as well as military leasing and pay-as-you-fly and/or the provision of after-sales support and MRO are just some of the possibilities. Success will depend upon either SMEs’ own ability to understand and continuously to adapt in a rapidly evolving future market, or on institutional initiatives designed to assist European small and medium enterprises and guide them towards the best option.
2. Future Standards, Regulation and Procedure Requirements

2.1. Legislative and Regulatory Needs

Europe has some of the most densely crowded skies in the world. In 2006 there were 10 million flights in European airspace, some 33,000 a-day at busy times. And the trend is up, despite the cooling economic climate that is affecting the aviation industry as much as any other.

Safety is the single, most important consideration that dominates the work on integration of UAS into controlled airspace. For European UAS, the need to guarantee an equivalent level of safety (ELOS) to manned aircraft, of whatever type, is the dominant priority. It is the governing principal guiding the continuing development of airworthiness certification standards and ATM procedures, along with their supporting technologies. Safety is also inextricably linked to Reliability and Security.

Together, these are the keystones upon which the future of civil and commercial operation of UAS depends. Without them, routine flight for UAVs in controlled airspace will not be possible.

<table>
<thead>
<tr>
<th>SAFETY</th>
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<tbody>
<tr>
<td><strong>RELIABILITY</strong></td>
<td><strong>SECURITY</strong></td>
</tr>
<tr>
<td><strong>Military</strong> = Complete mission.</td>
<td>• Secure C3 and datalinks (UAS equivalent to locked cockpit)</td>
</tr>
<tr>
<td><strong>Civilian</strong> = Complete mission without threat to life and property.</td>
<td>• No physical danger to public (e.g. from impact, accidental or deliberate)</td>
</tr>
<tr>
<td>▪ Powerplant</td>
<td>• Legitimacy of purpose (denial of access for criminal or terrorist use)</td>
</tr>
<tr>
<td>▪ Airframe</td>
<td></td>
</tr>
<tr>
<td>▪ Avionics, navigation, comms (incl. GCS)</td>
<td></td>
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<tr>
<td>▪ Crew training</td>
<td></td>
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<td>▪ (Payload)</td>
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Meanwhile, in those States with relevant regulations in place, all but the smallest UAVs, operating in visual line of sight (VLOS), will be required to
operate with individually issued Exemptions, or Permissions to Fly. These would usually require NOTAMS and other administrative procedures. Whilst these are becoming more easy to obtain they are nevertheless a cumbersome process and deny users the ability to ‘file and fly’ on demand. In addition to the flight clearance a user also needs to obtain a RF slot from a separate authority.

First of all, however, there has been the challenge of identifying and precisely defining what an ‘ELOS’ implies. In order to ensure the requisite equivalent level of safety, those drawing up the standards and legislation have, where possible and appropriate – and in order to avoid ‘reinventing the wheel’ – been drawing upon existing material, such as that which already applies to manned aircraft.

The other concern that has often been expressed where civilian UAS are concerned is that of privacy. Perhaps unsurprisingly, this has however come some way down the list among interviewees from industry and the regulatory authorities (see chart, below), but there are no clear reasons to suggest that it would be otherwise among the general public, provided the proper safeguards (technical and statutory) were in place.

![Levels of priority assigned to selected criteria](chart.png)

**Development of a Regulatory Framework**

Despite this, the levels of complexity involved with developing the technical, administrative and legal issues, and in reaching an agreed and a workable framework of standards, rules and regulations has, however, significantly delayed the process beyond anything that was originally anticipated.
EUROCONTROL is responsible for overall continental European ATM issues. With 38 members, its authority extends beyond the borders of the European Union. At the European Union level EASA⁸ and EUROCAE⁹ are handling the standards for airworthiness type certification.

The sheer number of people involved, the range of priorities and interests, methodologies and cultures, the widely varying levels of awareness and expertise among EDA participating Member States (pMS), and the need to reach agreement through consensus (EUROCONTROL does not have statutory authority over its members) have all contributed to the slow pace of progress.

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⁸ EASA - European Aviation Safety Agency
⁹ EUROCAE - European Organisation for Civil Aviation Equipment
A simplified view of the European Airworthiness Certification Process

European efforts towards achieving convergence on a UAS regulatory framework are centred on EUROCAE’s specialist Working Group, WG-73. This group of experts is specifically concerned with solving the problems confronting the introduction of UAVs into controlled airspace. Its brief is to produce recommendations – MASPS: Minimum Aviation System Performance Standards, and then MOPS: Minimum Operational Performance Standards – which will eventually be adopted by EASA and EUROCONTROL. These cover ATM, military involvement, navigation, radio spectrum, human factors, safety, security and communications standards, as well as R&D issues. Any MOPS – which form the basis of certification – have to be international and are therefore, to some degree at least, arrived at by consensus after a due process of debate and compromise since they have no statutory authority. Such a process takes time, further frustrating swift progress towards achieving UAV access to controlled airspace.
WG-73 has four Sub-groups, each one addressing a particular aspect of UAS standards. Although EASA is officially only concerned with UAVs with a mass of more than 150 kilos (less than this and they are the responsibility of local CAAs), with an eye to the future, WG-73 has added a Sub-group which is examining the role of small UAVs in the wider European context. In addition to representatives from EUROCONTROL and EASA, the Group’s leadership includes members from the North America: the FAA and RTCA’s Special Committee on UAVs (SC-203) and ICAO’s UASSG\(^\text{10}\). Crucially, the integration of high-level members from across the Atlantic ensures mutual alignment and harmonisation of both doctrine and practical solutions. The working group has 130 members in all drawn from across the range of relevant domains of expertise.

Initial expectations that a complete framework would eventually be rolled out as a cohesive whole has given way, over time, to a more sober assessment of the situation, as the scale of the task has become more apparent as it has unfolded.

\(^{10}\) ICAO - International Civil Aviation Organisation, UAS Study Group
It is now acknowledged that standards, rules and regulations – covering specific issues – will come into force sequentially over time, piece by piece, and, rather like a jigsaw puzzle, they will gradually coalesce until the whole edifice is in position. Completion is not anticipated before 2012. Indeed, it is more probable that UAS operation in controlled airspace will not begin to become routine until closer to 2015, and integration of UAS as part of the Single European Sky (SESAR) is not expected until after this project starts to come into effect from 2020.  

**Technology**

On the technology domain there is a political as well as an engineering dimension. In addition to the technical problems involved with producing a viable Sense and Avoid (S&A) system to acceptable standards, there is the additional challenge of acquiring suitable and secure (‘jam-proof’) radio frequency (RF) bandwidth. This applies to obtaining frequencies both for controlling and communicating with UAS as well as for their payloaddatalinks. For the larger platform operating in controlled airspace, two separate C2 frequencies are required: one for the ‘pilot’ and the other for ATC. In addition to this basic necessity are those frequencies required for use by the payload, sensors or whatever. The scale of the demand on the already tight RF spectrum is frequently underestimated.

In order to guarantee safe operation allocated frequencies need not only to be able to handle the required bandwidth but also need to be secured. The possibility of technical malfunction requires a failsafe system to be in place (e.g. automatic return to base). The need for communications links adequately to be protected from potential efforts hack into them and perhaps to hijack a UAV is also an important consideration.

The EDA is presently involved with work designed to present a case for debate at the International Telecommunications Union (ITU) World Telecommunications Conference in 2011 (WTC-11). It is fervently hoped that this will mark the point when this key issue will at last be addressed at the necessary (global) level, and a solution reached with a minimum of delay thereafter.
Meanwhile, the technology concern with the higher profile remains the acquisition of a viable S&A system. Such a mechanism remains the industry’s Holy Grail. However, certain elements of the UAS community insist that this does not represent a serious challenge: the technology exists. In one sense this is true, but the fact remains: a finished product, never mind a working prototype, has yet to see the light of day. Indeed, the problem is not the technology but the systems integration, and the miniaturisation required to make it work aboard a UAV. A significant amount of work is being devoted to this field, and it is one in which vigorous competition between European (and international) competitors can only be beneficial.

Given the difficulty in obtaining permission to test-fly in real European airspace conditions, the ability to do so in a synthetic environment has been invaluable. Simulation therefore is playing a key role in assisting the engineering development of systems, as well as with putting together a regulatory framework within which these are being designed to function.

**Working groups: synergy and overlap**

The complexity of the task, therefore, along with the differing priorities of the many stakeholders involved and the sometimes sporadic nature of essential funding, has meant that the pace of progress has been at times painfully slow. This has been one of the reasons behind the proliferation of Working Groups
or consortia springing up in order to address a particular issue or concern relevant to their particular area of interest. These initiatives have produced a series of roadmaps and guidelines detailing how best this very complex, even labyrinthine, subject can be addressed. Their focus has been in two principal areas, airworthiness certification standards for UAS and air traffic management (ATM) issues concerned with their integration into general air traffic (GAT). Naturally, the separate issues of the technology, airworthiness standards, and the development of the framework of ATM procedures associated with them are all interconnected.

Unfortunately, and although work is almost invariably carried out in a well-intentioned spirit of goodwill, co-operation and collaboration designed to reach convergence on the requisite rules and regulations, some duplication of effort and overlap, rather than the synergy desired has been inevitable. This has at time generated a certain amount of frustration among those who may already be working on the area concerned.

At present challenges exist not only at a national level among all pMS but at the European continental level as well. Commercial UAS with a mass of more than 150 Kilos come under the jurisdiction of EASA, with certain exceptions such as prototypes engaged in limited test flights. But smaller UAS are subject to a range of national controls which vary widely, from the non-existent to the beginnings of a workable solution.

**Varying levels of activity and awareness among EDA pMS**

Unsurprisingly, it is those nations where there is a either an active manufacturing lobby or a significant level of demand, or both, that are in the vanguard. And although national regulatory authorities are having to accommodate this demand – at its differing levels of intensity – they are usually not doing so independently, there is a constructive level of dialogue and co-operation between those involved. This exchange of information, consultation and co-operation is taking place at a local level (nationally) between the commercial sector, the regulatory authorities (e.g. national CAAs) and other stakeholders, including the Armed Forces of pMS. This
harmonisation process is also taking place internationally within Europe, with NATO, and with the FAA and other relevant groups in the United States. There is general recognition that it is essential that, from the outset, there should emerge a coherent and internationally accepted, practical set of rules and standards.

![Map of EU pMS showing level of UAV awareness and activity](source: Frost & Sullivan)

**Level of UAV awareness and activity among EU pMS**

However, this is proving a challenge since pMS are by no means ‘on the same page’. Although active interest from potential end-users or a nascent manufacturing community is what seems to be driving local Authorities to develop a regulatory framework, it has been found that this is not always the case. In some areas officials appear remain un-sensitised to the need for action, and funding for the development of procedures is often absent.

Nevertheless, this low level of activity also has its advantages: it means there is less likelihood of confliction between independently generated procedures (since there are none), and officials in this category, when interviewed, have tended to indicate a willingness to fall into line with European guidelines once these come into being. In several cases, although there is no overt activity, potential official stakeholders are monitoring the situation and are aware of what is going on. Many for example are familiar with the UK CAA’s seminal document ‘Unmanned Aircraft System Operations in UK Airspace – Guidance’. This document (usually referred to simply as ‘CAP-722’) has proved useful as a basis for developing more detailed guidelines.
2.2. **Standardisation Issues**

The need for regulations and procedures has already been explored. That these should be standardised, not only across the European Union, and not only across the European continent, but globally, is evident.

This harmonised approach is the one that has been adopted by all European stakeholders. As already covered, above, these are working in close step with colleagues across the Atlantic to bring forth an integrated framework of regulations based upon common standards and agreed procedures.

These are being developed not only in consultation with international civil aviation bodies but their military counterparts as well, where appropriate, and where compatibility or interoperability is necessary. The experience gained from military use has been vital in certain areas, but its application is of limited relevance since the emphasis in the military domain is on the completion of the mission, virtually at any cost. In the civilian sector the over-riding concern is – once again – with safety. This has meant that the NATO STANAGs (standardisation agreements) have been of less use than may otherwise have been expected. STANAG 4671, for example deals with flight rules for fixed-wing UAVs, but not VTOLS. It was developed from a French DGA requirement, USAR. NATO also hosts the FINAS project (Flight in Non-segregated Airspace) whose brief is ‘...to recommend and document NATO-wide guidelines to allow the cross-border operation of unmanned aerial vehicles (UAVs) in non-segregated airspace’. FINAS is represented in WG-73, in EUROCONTROL, SC-203 in the USA) and other stakeholder bodies.

Even within NATO the magnitude of this assignment is recognised, and it is accepted that output will take place in an iterative manner and not in a single ‘Big Bang’.

Nevertheless, both STANAGS and operational military experience have made an important contribution in certain areas and have provided a point of departure for developing civilian standards covering such areas as GCS interoperability and human factors (ergonomics) specifications (STANAG 4586), and they may assist with a standardised approach to UAS operator training (STANAG 4670).
Standardisation is also a cornerstone of the WCT-11 submission from potential European UAS users. The ring-fencing of certain, standard, radio frequencies is essential in order to maintain a coherent, harmonised and structured approach – and to enable the manufacture of standard components.

At present, the future of a European UAS industry, and its market – local and worldwide – depends on the development of a supporting structure of technical solutions and regulatory procedures. The drive towards this goal is centred on EUROCAE’s WG-73. The output of this expert Working Group will be used by EUROCONTROL, in concert with ICAO at a global level.

Meanwhile, a number of parallel groups and consortia have been appearing in the landscape, sometimes apparently duplicating the efforts of established working groups. In order to avoid further duplication of effort as well as the development of potentially conflicting procedures or incompatible technologies, an even greater level of co-ordination than already exists appears to be necessary.

Facilitation at a high level would also maximise the use of already scarce resources. At the moment many key experts are either working voluntarily for what they regard as a worthy cause or are on secondment form their ‘day jobs’ in industry or with regulatory authorities. It happens that they may have to have to return to these, often at short notice at a crucial stage in proceedings.

The complexity of the problems in hand, coupled with the nature of the mechanisms that have been assembled to tackle it mean that progress has been slow, and at times this has even appeared to grind to a halt. What appears to be necessary is a way of ‘cutting the Gordian knot’. This could be achieved through the good offices of a facilitative or supervisory entity whose mission it would be to assist with the smooth exchange of information through a central Exchange. This body could be a new creation, or it may emerge from an existing organisation. In any case, its task would be to assure maximum efficiency in the use of resources, both existing – and where necessary, newly
commissioned – resources in order to reach the identified goals by the best route, without cutting corners in the process.

With all parties at a similar stage in the development of an internationally applicable framework, Europe has the rare potential of entering the civil and commercial market on a par with its principal overseas competitors.

Nevertheless, for all concerned in the race to enter this market safety cannot be sacrificed for the sake of expediency, its predominant role cannot be compromised.
3. Potential Options and Measures for EU, National Governments and Industry

A diffuse potential (or current, on the defence side) customer base and the absence of legislation and regulations for safe flight in integrated airspace has shaped un-coordinated and ad-hoc initiatives with regards to the development of civilian-use UAVs. At the moment, rules vary from one country to another, level of engagement is unequal and technological know-how is disproportionate. Such incoherence makes things more difficult for manufacturers and operators, delaying the creation of a coherent civil UAV agenda across the European Union.

In this sphere, European UAV manufacturers are pushed by several drivers (i.e. expectations of a large and diverse civil market) and at the same time held back by various restraints, primarily of regulatory nature. For example, UAV developers and possible end-users are waiting for legislative initiatives from national and supra-national authorities on insertion of UAVs in civil aerospace in order to proceed with further investments in civil UAVs and/or development of required technologies. At their end, policy makers, CAAs and other relevant national and supra-national authorities are waiting for industry to demonstrate its ability to guarantee the quality of current see-and-avoid technologies in order to ensure the equivalent level of safety to manned platforms for the use of UAVs in European airspace. An arbiter is required that will finally cut the ‘Gordian knot’ of this impasse and will permit the natural development of equipment and technologies to take its course.

Another example is with reference to the use of UAVs to date at national level. The fragmentation of the European market into national markets with established selected suppliers (as seen in cases of UAV procurement on the defence side, the only market that can currently be accurately estimated and analysed) in many cases has repressed innovation at European level and weakened the business case for European companies (particularly SMEs) to invest and fully commit to the development or improvement of UAV-related technologies. These companies decided that with limited funds it was safer to stick to things they knew well, such as platform development, hoping that this
would provide them with additional financing or commercial benefit in a market that already has too many models of platforms but has not resolved the problem of how to make them fly alongside manned platforms.

A further market fragmentation is caused by the great disproportion in general understanding of the UAV field and UAV culture between Member States that were early adopters of UAV technology and those who still need to catch up. This effectively creates a circle of ‘In’ and ‘Out’ countries where the ‘Out-countries’ have very little impetus not only to develop UAV-related technologies but to consider the future changes and requirements that this technology is expected to bring.

All this is not to say that there are no positive efforts that can be encountered in the European market. EUROCAE’s Working Group WG-73 is working on a voluntary basis to bring together European governments and manufacturers as well as international participants and Armed Forces in order to discuss the creation of a regulatory framework on behalf of EUROCONTROL. Despite the good will, this initiative and many others like it made a relatively slow progress and are likely to remain at slow pace without a major practical support from an authority that would give the whole arrangement an institutional and regulatory gravitas.

Under the current climate the steps that the European Commission could take are the following:

- Do nothing: The current issues are likely to be resolved organically, but within a time-frame that is difficult to predict and technology that will not necessarily be European. If the majority of important industrial participants believe that that is the best path this laissez-faire approach is a valid option.

- Creation of EUASF: This would be a single point for information exchange between the institutional, academic and industrial participants. Details of this proposed solution is given below.

- Make adequate funding available for specific projects that would aim to resolve the current issues: Funding would be consistently available for projects that have a stated goal to speed up the creation of necessary
standards and regulation as well as specific technologies that are considered an absolute imperative (i.e. sense-and-avoid and safety-related technologies). This funding could be in a shape of a multi-million euro integrated project over a period of several years.


As a new technology, there is currently little room for UAVs within the existing framework of rules in the European non-segregated airspace. In order to promote its success, a great deal of adjustment is necessary. As mentioned earlier in this study, Europe is seen by many experts as potentially being quicker in tackling these issues than US authorities.

Having said that, the European Commission as well as national governments could make a substantial contribution by promoting and funding additional UAV-specific research and technological development should they choose to follow the path of more direct involvement. This is especially the case in the vital area of insertion in non-segregated airspace. As there is no separate thematic area on UAVs in European Commission’s R&D Framework Programme or any similar national efforts, all the progress made on the sense-and-avoid systems came from initiatives of large manufacturers thus effectively excluding the SMEs. Similar, but fully funded and more widely spread initiatives would lead to further reductions in manufacturing, training and operating costs as well as the other significant aspect, the improved reliability, and would greatly help at clearing the path toward the civil UAV market.

Although it is almost taken for granted, it is important to stress that the first objective of any combined actions involving European and national authorities should ensure that excessive duplication of research and development efforts within industry should be avoided at any cost. In other words, before any other steps are taken, an action plan should be created, that would support European UAV developers’ research efforts and promoting clusters of excellence, while at the same time avoiding duplication up and until the point where technological barriers to the insertion of civil UAVs into civil aerospace
are finally removed. After that milestone was achieved the goals would shift and the emphasis would move towards maintaining domestic and international competitiveness.

### 3.2. EUASF

Considering the current European market dynamics, Frost & Sullivan proposes the creation of a European Commission group which would work on supporting European UAV manufacturers by a) Monitoring industry developments in the field and sharing information amongst participants, b) Funding R&D programmes on critical technology and c) Being a co-ordinated interface between industry and regulatory authorities across Europe. By bringing all the actors around one table and allowing them to share their progress, views and grievances the EU could eliminate duplication of efforts within industry and help the European UAV domain to overcome the issue of ‘industry achievements vs. regulation requirements’.

To understand how the European Union Unmanned Aerial Systems Forum (EUASF) would proceed, it is paramount to understand how it would interact with industry, national governments and current regulatory authorities.

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**Potential future structure involving a suggested European UAS Forum, which could provide a central information source available to all stakeholders**

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*Source: Frost & Sullivan*
a) Monitoring industry and sharing information amongst participants

The main role a European Commission UAV group would play is to monitor the development of the industry and support regulatory authorities by sharing information on latest industry developments. The idea is neither to prevent nor impose policies on the European UAV industry but help to them to avoid investments in areas which are already considered saturated, help them to identify technology gaps which can be tackled, facilitate the collaboration between different developers – Primes, SMEs and Academics. Finally, this group could become an information sharing portal where industry could optimize its investments.

b) Funding critical technology R&D programmes

There are a number of critical technology areas in the development of UAVs 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. These technologies are considered very challenging and are likely to be the ones which will provide more competitive advantages to whoever is interested in innovating them.

Taking this into consideration, by monitoring and supporting the European UAV industry, the EUASF group would provide a powerful voice calling for more direct UAV-related activities in Framework Programmes and possibly even a separate Theme. Working with primes, SMEs and academic, the group would be able to co-ordinate and focus on UAV technological areas in which the European industry is lagging behind. Also, the group could serve as a useful forum for companies looking to partner with other companies on technical and strategic issues related to UAVs.
c) **Being a co-ordinated interface between industry and regulatory authorities across Europe**

As an information sharing portal, the EUASF group would not only provide information to manufacturers. The European UAV industry, via this group, would have a formal representation (one voice) before regulatory authorities currently working on the UAV spectrum. In this particular case, the EUASF group could provide an environment where the industry and EUROCONTROL, national CAAs, EASA and other bodies could meet and jointly work to facilitate the regulation and certification creation process. As a part of this activity an informational portal similar to that created by EDA can be put into action, ensuring that everyone is informed of emerging requirements, research activities and latest technological achievements so that on the one hand any eventual platforms or equipment procurement is transparent and on the other duplication of research effort is avoided.

### 3.3. **EU Member States**

National Governments (i.e. Ministries of Technology and Transport) as well as other relevant national institutions (CAAs, ATM authorities) should participate in the proposed EUASF in order to better co-ordinate the allocation of UAV-specific R&D funding, and legislative initiatives concerning the insertion of UAVs into civil aerospace. Their participation would also be beneficial for the potential creation of clusters of excellence for UAV technology across EU. Such initiatives already exist in countries that are UAV technology leaders but are virtually unknown in countries that can be considered followers. National governments of several countries could partner to create clusters of excellence at regional level which would be jointly funded with potential support from various European Union funds that could be made available for such types of initiatives.

National CAAs and ATM authorities have a varying level of interest and knowledge of UAS-related issues and a forum where leading countries could pass on their experiences and where issues could be discussed could potentially be extremely beneficial for future insertion and certification effort.
Such forum would represent a clear signal that UAVs are considered to be an accepted technology at industrial and institutional level and that UAV technology should be taken into consideration in any future planning.

Finally, the national governments could play an extremely important role in promoting the UAV technology to the general public thus ensuring public acceptance. As national government agencies (Coast Guard, Police) are likely to be among the first users of civil UAS, successful demonstration of technology, its safety and its cost-effectiveness could go a long way towards ensuring that the general public does not perceive UAS as a danger. So far, military use of UAS (especially armed UAVs) has caused ambiguous reactions, although the general public did accept and appreciate their ‘life-saving’ role.

### 3.4. What should Industry do?

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 is an imperative and as was mentioned earlier, it should be the initial goal of EUASF. Engineers and systems integrators will need to work collaboratively with legislators instead of each waiting for the other to take the initiative.

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. However, SMEs must be discouraged from excessive duplication of effort, particularly in the platform design and manufacture arena and this is the other stated goal of EUASF.

3.5. Proposed Options for Utilisation of EU Defence/Security Funds

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, most of the current market players believe that they have no choice but to concentrate most of their efforts on military UAS applications due to the bad visibility of what the future civilian market may hold.

This has in many cases shifted efforts away from areas of development that can be considered strategic for the civil side. 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) 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.

Therefore, in many cases the current civil/military technological synergy stems from necessity rather than choice. This is expected to change once the technological development for sense-and-avoid and other required solutions finally reaches a level where they will be generally applied and demand for civilian UAVs crosses a significance threshold. Once that happens, the majority of solutions will come from dedicated, civil-orientated sources and will possibly even be re-adapted for military purposes.

In the interim however, a continued synergy between civil and military research is of absolute importance, and initiatives from essentially defence orientated organisations such as EDA and NATO go some way towards helping the insertion of UAVs in civil aerospace. EDA continues to use military funding (and expertise) to support development of civilian ATM and Airworthiness requirements. EDA is also working on allocating areas of the RF spectrum for UAS at the European level and 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.

NATO's work on STANAG 4671 (UAV operations) and STANAG 4670 (UAV training) have been extensively used as precursors for application of guidelines within the civilian sector. STANAG 4671 was based upon work originally sponsored by France’s DGA to develop USAR (UAV Systems Airworthiness Requirements) for fixed-wing UAVs.

These efforts indicate that insertion of UAVs into non-segregated aerospace is now of equal priority to civil and military institutional players, and the response from industry indicates that they now share this view. Therefore, the efforts by EDA should continue and must be encouraged.

Funding on the security side can be channelled through existing institutions such as FRONTEX or EUROPOL and directed towards specific areas of research. For example, FRONTEX could play a role similar to EDA in terms of
both equipment procurement support and support for border security-specific sensors and equipment development. It can serve as a channel to voice Member States’ requirements and to inform the relevant actors of new technological developments. Finally, FRONTEX could pool UAS and other resources already available to Member States and direct them to EU border areas where they are most needed at that point in time.
4. Appendices
## 4.1. Appendix I

### GLOSSARY OF ACRONYMS

| A | ALO | Avión Ligero de Observación (INTA Project, Spain)  
   | ASAS | Airborne Separation Assistance System  
   | ASTRAEA | Autonomous System Technology Related Airborne Evaluation and Assessment (UK)  
   | ATC | Air Traffic Control  
   | ATM | Air Traffic Management  
|---|---|---|---|---|---|
| B | BLOS | Beyond Line of Sight (see LOS and VLOS)  
| C | CAA | Civil Aviation Authority  
   | CAP-722 | UK Civil Aviation Authority document: Unmanned Aircraft System Operations Airspace - Guidance  
   | CONOPS | Concept of Operations  
   | COTS | Commercial, Off-the-Shelf  
| D | DGA | Délégation générale pour l’armement (France)  
   | DoD | Department of Defense (USA)  
   | DRAC | Drone de Reconnaissance Au Contact (French MUAV)  
| E | EADS | European Aeronautic Defence and Space Company NV  
   | EASA | European Aviation Safety Agency  
   | EDA | European Defence Agency  
   | EOS | Equivalent Level of Safety (i.e. to manned aircraft)  
   | EAS | European Space Agency  
   | EU | European Union  
   | EUASI | European UAS Forum  
   | EUROCAE | European Organisation for Civil Aviation Equipment  
   | EUROCONTROL | European Organisation for The Safety of Air Navigation  
| F | FAA | Federal Aviation Authority (USA)  
   | FAR | Flight Acceptance Review  
   | FINAS | Flight in Non-segregated Air Space (NATO Sub-group AG/7)  
| G | GAT | General Air Traffic (see OAT)  
   | GCS | Ground Control Station  
| H | HALE | High Altitude – Long Endurance  
| I | IASA | International Aviation Safety Assessments  
   | ICAO | International Civil Aviation Organisation  
   | IDF | Israel Defence Forces  
   | IFATS | Innovative Future Air Transport System  
   | IFR | Instrument Flight Rules (see VFR)  
   | INOUI | Innovative Operational UAS Integration. UAVs>>ATM (F) (D) (E)  
   | INTA | Instituto Nacional de Técnica Aeroespacial (Spain)  
   | ISR | Intelligence Surveillance and Reconnaissance  
   | ITU | International Telecommunication Union (part of the UN)  
   | LWGLUAS | Interim Working Group on Light UAS  
| J | JAA | Joint Aviation Authorities (Now defunct, see EASA)  
   | JAPCC | Joint Air Power Competence Centre (NATO)  
   | JAR | Joint Airworthiness Regulations  
   | JARUS | Joint Authorities for Rulemaking on Unmanned Systems  
   | JV | Joint venture  
| L | LTA | Lighter Than Air (airships, balloons, blimps, aerostats, etc.)  
   | LUAV | Light UAV (European civilian designation of smaller UAVs)  
   | LOS | Line of Sight (see BLOS and VLOS)  
| M | MASP | Minimum Aviation System Performance Standards (see MOPS)  
   | MALE | Medium Altitude – Long Endurance  

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>MAV</td>
<td>Micro Air Vehicle</td>
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<tr>
<td>MAVDEM</td>
<td>Mini Aerial Vehicle Demonstrator (Multi-national consortium)</td>
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<tr>
<td>MIDCAS</td>
<td>MIDAir Collision Avoidance System (Europe. See TCAS)</td>
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<tr>
<td>MoD</td>
<td>Ministry of Defence</td>
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<tr>
<td>MOPS</td>
<td>Minimum Operational Performance Specification (see MASPS)</td>
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<tr>
<td>MRO</td>
<td>Maintenance Repair and Overhaul</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean Time Before Failure</td>
</tr>
<tr>
<td>NAV</td>
<td>Nano Air Vehicle</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
</tr>
<tr>
<td>NOTAMS</td>
<td>Notice To Airmen (alerts of hazards to air navigation)</td>
</tr>
<tr>
<td>OAT</td>
<td>Operational Air Traffic(^\text{11}) (see GAT)</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>ONERA</td>
<td>Office National d'Etudes et de Recherche Aérospatiales</td>
</tr>
<tr>
<td>OPV</td>
<td>Optionally Piloted Vehicle</td>
</tr>
<tr>
<td>pMS</td>
<td>participating Member States (of the EU)</td>
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<tr>
<td>RAF</td>
<td>Royal Air Force</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<tr>
<td>RTCA</td>
<td>American consulting group working on UAS regulations</td>
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<tr>
<td>S&amp;A (SAA)</td>
<td>Sense and Avoid (See and Avoid)</td>
</tr>
<tr>
<td>SAR</td>
<td>Synthetic Aperture Radar</td>
</tr>
<tr>
<td>SC-203</td>
<td>RTCA’s Special Committee working on UAS regulations</td>
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<tr>
<td>SESAR</td>
<td>Single European Sky ATM Research (formerly “SESAME”)</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure(s)</td>
</tr>
<tr>
<td>SME</td>
<td>Small/Medium-sized Enterprise</td>
</tr>
<tr>
<td>S/MUAS</td>
<td>Small and Mini-Unmanned Aerial Systems</td>
</tr>
<tr>
<td>STANAG</td>
<td>NATO Standardisation Agreement</td>
</tr>
<tr>
<td>SWIMS</td>
<td>System-Wide Information Management</td>
</tr>
<tr>
<td>TCAS</td>
<td>Traffic Collision Avoidance System (USA. See MIDCAS)</td>
</tr>
<tr>
<td>TUAV</td>
<td>Tactical Unmanned Aerial Vehicle</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned/uninhabited Air Vehicle (airframe / platform only)</td>
</tr>
<tr>
<td>UAS</td>
<td>Unmanned Aerial System (i.e. Airframe + GCS, and ancillaries)</td>
</tr>
<tr>
<td>UCAV</td>
<td>Unmanned Combat Air Vehicle</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>USAR</td>
<td>UAV Systems Airworthiness Requirements (DGA) &gt; STANAG 4671</td>
</tr>
<tr>
<td>USICO</td>
<td>Unmanned aerial vehicle Safety Issues for Civil Operation</td>
</tr>
<tr>
<td>V</td>
<td>Visual Flight Rules (see IFR)</td>
</tr>
<tr>
<td>VHALE</td>
<td>Very High Altitude – Long Endurance</td>
</tr>
<tr>
<td>VLOS</td>
<td>Visual Line of Sight (see BLOS and LOS)</td>
</tr>
<tr>
<td>VTOL</td>
<td>Vertical Take-Off / Landing</td>
</tr>
<tr>
<td>VUAV</td>
<td>Vertical Take-Off / Landing UAV (USA)</td>
</tr>
<tr>
<td>WG-73</td>
<td>EUROCAE Working Group on UAS. It has four Sub-Groups SG-1–SG-4</td>
</tr>
<tr>
<td>WRC-11</td>
<td>ITU World Radiocommunication Conference - 2011</td>
</tr>
</tbody>
</table>

\(^\text{11}\) OAT encompasses all flights which do not comply with the provisions stated for general air traffic (GAT) and for which rules and procedures have been specified by appropriate national authorities. (EUROCONTROL EATM Glossary of Terms)
4.2. Appendix II

Working Groups

This list is a brief summary of selected European groups not already covered in the Study.

NATO groups working on UAS-related issues

JCGUAV (Joint Capability Group – UAVs), including:

- **FINAS** (Flight in Non-segregated Airspace)
  A NATO project concerning 150–20,000 kg fixed-wing UAVs “…to recommend and document NATO-wide guidelines to allow the cross-border operation of unmanned aerial vehicles (UAVs) in non-segregated airspace”. FINAS is represented in WG-73, in EUROCONTROL, SC-203 in the USA) and other stakeholder bodies.
  Participating nations: UK (Chair), Canada, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden and Turkey.

- **Interfaces of UAV Control Systems for NATO UAV Interoperable Systems**

- **Interoperable Command and Control Data Link for UAV (IC2DL)**

- **UAV Systems Airworthiness Requirements**

- **UAV Workshop**

**ATLANTIDA** (Application of Leader Technologies to Unmanned Airships for the Investigation and Development in ATM)
A Spanish-based group concerned with ATM issues and unmanned airships (ULAVs) led by Boeing Research and Technology Europe.

**JARUS**
JARUS is an initiative of the Dutch CAA which was formed to address perceived gaps in the process. ‘The goal of JARUS is to harmonize the requirements and limitations for Light UAS (<150kg) certification and operation across the European Union. The output of JARUS will consist of a single set of draft airworthiness, operational and airspace requirements.'
JARUS will co-ordinate their activities closely with EUROCAE WG-73’s Sub-Group on Light UAS (SG-4). JARUS is making an effort to co-ordinate its activities with the FAA, USA, Transport Canada and CASA, Australia.\footnote{Source: JARUS}

**INOUI**

The Objective of the INOUI consortium is to provide a roadmap for the integration of UAS into the European ATM system with particular reference to the Single European Skies (SESAR) programme, due to come into effect from 2020-2025. The project was due to run for two years until October 2009 and sees itself as a “condensation core” which will bring about quickest, yet realistic steps for widespread use of UAS for selected dedicated missions. The group’s first workshop, in Mallorca during October 2008 also involved a number of participants from other groups covering related fields, both from Europe and beyond.

Funding is 50 per cent provided by the European Commission, with the balance coming from industry. Its members are DFS, Isdefe, Boeing Research & Technology Europe, INNAXIS, Rheinmetall Defence Electronics, Onera, OFFIS, with DFS in the project management role.

**EDA – MIDCAS and Air4All**

Although officially concerned with military matters, the EDA has been a major contributor to progress in this area, and has sponsored MIDCAS and the Air4All consortium.

**MIDCAS**, as described above, is a multi-national effort producing the standards for a MID-Air Collision Avoidance System. The project’s scope includes the production of a functioning model.

**Air4All** is an industry-based EDA-sponsored consortium. Their brief has been to produce a ‘roadmap’ which describes ‘a common strategy for the seamless integration of UAS within General Air Traffic’\footnote{Source: Air4All} (GAT). Air4All conducted a series of ‘Stakeholder Workshops’ before publishing its

**UAV DACH**
A German language UAS working group investigating S&A solutions under the SAvE banner (Sense and Avoid Expert System). The consortium includes Austrian, Dutch, German and Swiss participants from these countries’ major aerospace companies.

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