TNO Quality of Life

Schoemakerstraat 97
P.O. Box 6030
2600 JA Delft
The Netherlands

www.tno.nl

T +31 15 269 54 43
F +31 15 269 54 60
info-kvl@tno.nl

TNO report: Final

Development of a European Defence Technological and Industrial Base

Annex report

Date	September 2009
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Author(s)	F. Bekkers (TNO)
	M. Butter (TNO)
	E. Anders Eriksson (FOI)
	E. Frinking (TNO)
	K. Hartley (CDE)
	D. Hoffmans (TNO)
	M. Leis (TNO)
	M. Lundmark (FOI)
	H. Masson (FRS)
	A. Rensma (TNO)
	G. Willemsen (TNO)
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Introduction to the report

This document includes the Annexes to the report "Development of a European Defence Technological and Industrial Base", which integrates the several outcomes of a study to obtain an in-depth understanding of consequences on the industry structure of the Europeanization of the defense-related industries and markets. The main report identifies possible initiatives for the European Commission and/or the European Defense Agency and contains policy recommendations on various levels.

This Annex report includes the following sections:

- Annex A: The EU defence industrial base
- Annex B: Country case studies
- Annex C: Key technological change driver
- Annex D: Trends in innovation
- Annex E: Primes and the EDTIB

A Annex: The EU defence industrial base

Introduction[1]

1. This Appendix presents a standard industrial economics analysis of the EU Defence Industrial Base. **It forms the background to Chapter 2 of the Main Report which presents a sector analysis**. The EU Defence Industrial Base will be analysed initially by using a structure-conduct-performance approach, starting with industry size, followed by sections on structure, conduct and performance. The approach is modified to include the Porter model of international competitiveness. The industry developments will also be assessed using a drivers for change framework. Available published data are used and there is an assessment of its quality.

A. Industry Size

Defence Industry Employment, 1990 to 2003 (BICC data)

2. Initially, the BICC data base is used. Table 1 shows that in 2003 within Europe, the major defence industries were located in France and the UK accounting for 57% of Europe's defence industry employment. In 2003, Germany was the next largest employer, followed by Poland, Italy, Bulgaria, Sweden and Spain: this additional group of 6 countries accounted for some 30% of total European defence industry employment.

3. Table 1 is also notable for showing major employment reductions between 1990 and 2003. These resulted from reductions in defence spending reflecting the disarmament following the end of the Cold War and the search for a Peace Dividend. The employment reductions were substantial, especially in some East European countries. By 2003, total European defence industry employment was 40% of its 1990 level, with major reductions in Estonia, Germany, Hungary, Italy, Poland, Romania, Slovakia and Spain. In total, almost 1.2 million defence industry workers were released from Europe's defence industry sector. Of course, not all these redundant workers were re-employed in the civil sector: some remained unemployed; some retired; some might have emigrated with much depending on the transferability of their skills and the relative attractiveness of work (income) versus leisure.

Table 1. EU Defence Industry Employment, 1990 – 2003

Numbers in (000s)

Country	1990	2003
Austria	5	3
Belgium	25	6
Bulgaria	20	25
Cyprus	Na	Na
Czech Republic	47	15
Denmark	7	5
Estonia	100	10
Finland	10	10
France	382	240

[1] Thanks are due to Martin Lundmark and to Helene Masson for both comments and data for this work package.

Germany	240	80
Greece	15	15
Hungary	33	2
Ireland	Na	Na
Italy	80	26
Latvia	Na	Na
Lithuania	Na	Na
Luxembourg	Na	Na
Malta	Na	Na
Netherlands	20	10
Poland	180	50
Portugal	10	5
Romania	90	18
Slovakia	93	7
Slovenia	Na	Na
Spain	100	20
Sweden	40	25
UK	440	200
Total Europe	1937	772
USA	3105	2700

Note:
i) Na is not available, usually meaning that there is no defence industry
ii) Some data are not consistent with data provided by national governments –e.g. UK defence industry employment in 2003 was 310,000 (MoD/DASA).
iii) After 2005, BICC no longer published employment data.

Source: BICC (2002; 2005).

Alternative employment estimates

4. There are alternative estimates of total employment in EU defence industries. A BIPE study estimated that European defence-related activities employed **1,644,000 personnel** directly and indirectly in 2006 (BIPE, 2008); but this figure included employment in a defence company's civil activities together with estimates of indirect employment in related tier 3 and higher industries (the basis for estimating such indirect employment was not explained: BIPE(2008)). The same BIPE study also estimated employment in defence activities only. On this basis, direct employment in defence prime contractors, tier 1 firms and tier 2 contractors linked to defence was a total of **567,000 personnel** in 2006 (BIPE, 2008, p16).

5. Further employment estimates are provided annually by the Aerospace and Defence Industries Association of Europe (ASD). In 2007, ASD reported total employment in the European aerospace and defence industries as **649,000 personnel** and annual sales of Euros 132.2 billion (ASD, 2007). This employment total comprised 106,200 personnel employed in the European land sector and 71,100 employed in the European naval sector (total of 177,300 people employed in land and naval sectors: ASD, 2007). The remaining employment was in the Aerospace sector; but these numbers comprised both civil as well as military employment. The ASD estimates also exclude thousands of supplier companies in the EU whose principal interests are not in these sectors and they include states which are not members of the EU. Furthermore, the ASD data differ from some of the official national estimates. For example, the UK MoD estimated total

employment in the UK defence industries at 310,000 personnel in 2005/06 whereas the corresponding number for ASD was 159,100 personnel(DASA, 2007; ASD, 2005). Table 1A shows the ASD employment data for 2007.

Table 1B. EU Defence Industry Employment, 2007

Nation	Employment	Nation	Employment
France	159900	Switzerland	8800
UK	154900	Finland	8400
Germany	106300	Belgium	8200
Italy	51300	Greece	7800
Spain	38000	Austria	7200
Sweden	21900	Ireland	5700
Netherlands	20300	Portugal	5500
Poland	16200	Norway	5400
Czech Rep	11100	Denmark	2300
Turkey	9000	Luxembourg	800

Source: ASD (2007)

B. Industry Structure

Europe's arms companies

6. Data on the EUs top defence companies in 2006 are shown in Table 2. This is based on the SIPRI list of the top 100 largest arms companies in the world (excluding China: SIPRI Yearbook, 2008). There are some distinctive features of the firms in 2006:

i) Europe accounted for 33 of the world's top 100 arms companies (including one Swiss and one Norwegian firm and excluding all subsidiaries so avoiding double-counting).

ii) Few firms are 100% defence-dependent (BAE Systems Inc: US subsidiary of BAE Systems; Elettronica; MBDA (subsidiary); DCN; Nexter; MBDA Italia (subsidiary); Oto Melara (subsidiary); Santa Barbara Sistemas (subsidiary); Thales Nederland (subsidiary): some of these are subsidiaries). If the 'cut-off' is lowered to arms sales accounting for 75% - 99% of total sales, the number of firms with such defence-dependency rises to a further twelve (including subsidiaries: e.g. BAE Systems with a 95% arms share; Agusta Westland; Saab; Patria; QinetiQ; Ultra Electronics).

iii) Almost half of the arms firms which are 100% defence-dependent are single arms product firms (e.g. electronics; missiles; motor vehicles; ships). Also, there were 20 European arms firms which were single product arms firms representing 60% of European arms firms (including Others group but excluding subsidiaries)[2].

[2] Throughout this Appendix, products refer to arms products only. Firms might have a range of civil products as part of their business; but such civil products are not reported in this analysis. For example, a single product arms firm might specialise in, say, missiles or electronics or shipbuilding. Dassault, for example, specialises in military aircraft but also produces civil/business aircraft; Rolls-Royce produces both military and civil aero-engines as well as nuclear and marine propulsion systems.

iv) The range of arms products. Typically, aerospace companies were amongst the largest in the group, supplying a range of defence products and equipment such as aircraft, electronics, missiles and small arms (e.g. BAE; EADS; Saab; Thales). Their size and range of products suggests that such firms might be exploiting economies of scale, learning and scope. Few aerospace companies specialised in one arms product and these included Rolls-Royce (engines); Dassault in aircraft; AgustaWestland and Eurocopter in helicopters (being subsidiaries of Finmeccanica and EADS, respectively).

v) Warship builders were distinctive. The majority of warship builders specialised in shipbuilding (six of the eight in the Table built only ships and two built ships and other defence equipment (BAE Systems; Babcock). Most shipbuilders were relatively small companies suggesting a failure to exploit the economies of scale, learning and scope available to larger companies (probably reflecting small national orders and preferential purchasing). Compared with European aerospace, there is no significant and successful record of international collaboration in European warship building. However, there has been some consolidation of European shipbuilding. For example, BAE Systems owns yards at Barrow-in-Furness (previously VSEL), Govan and Scotstoun (Yarrow) and there is an alliance with Vosper Thorneycroft (VT Group); ThyssenKrupp (Germany) owns Blohm+Voss, HDW, Nordseewerke, Hellenic Shipyards (Greece) and Kockums (Sweden). See Chapter 2 for more details on shipbuilding.

vi) Aero-engine companies tended to be single product arms firms, usually with a substantial civil business. There was no vertical integration between aero-engine and aerospace firms.

Table 2. Top European Arms Companies, 2006

Company	**Country**	**Sector**	**Arms sales (US$ millions)**	**Arms employment**	**Arms sales as share of total sales (%)**
BAE Systems	UK	A Ac El Mi MV SA/A Sh	24060	84170	95
EADS	W Europe	Ac El Mi Sp	12600	29203	25
BAE Systems Inc (BAE Systems,UK:S)	USA	A El MV SA/A	11280	51700	100
Finmeccanica	Italy	A Ac El Mi MV SA/A	8990	33094	57
Thales	France	El Mi SA/A	8240	33382	64
MBDA (BAE; EADS; Finmeccanica: S)	Europe	Mi	4140	10400	100

Rolls-Royce	UK	Eng	3960	11400	30
SAFRAN	France	Comp (Ac El Eng)	3780	17181	28
DCN	France	Sh	3400	12460	100
Agusta Westland (Finmeccanica: S)	Italy	Ac	2820	7300	82
Eurocopter Group (EADS: S)	Europe	Ac	2580	7247	54
Saab	Sweden	Ac El Mi	2250	10712	79
Selex Sensors and Airborne Systems (Finmeccanica)	Italy	Comp (El)	2060	6740	94
Rheinmetall	Germany	A El MV SA/A	1810	7520	40
Thyssen Krupp	Germany	Sh	1620	5628	3
QinetiQ	UK	Comp (Oth)	1610	10260	76
CEA	France	Oth	1590	5825	38
Dassault Aviation	France	Ac	1570	4533	38
Smiths	UK	El	1480	7204	23
Alenia Aeronautica (Finmeccanica)	Italy	Ac	1450	7284	60
VT Group	UK	Sh	1400	9804	76
EADS Astrium (EADS: S)	France	Sp	1290	3818	32
Krauss-Maffei Wegmann	Germany	MV	1190	2660	95
Serco	UK	Oth	1170	10023	25
Cobham	UK	Comp (Ac El)	1140	5800	61
Navantia	Spain	Sh	1110	4392	79
Nexter	France	A MV SA/A	900	2490	100
Diehl	Germany	Mi SA/A	850	3341	32
Devonport Management (KBR, USA: S)	UK	Sh	780	4879	94
Babcock International Group	UK	Sh Oth	760	4050	42
GKN	UK	Comp (Ac)	740	3612	10
Fincantieri	Italy	Sh	660	2070	22
Selex Communication (Finmeccanica: S)	Italy	Comp (El Oth)	630	3928	80
MTU Aero Engines	Germany	Eng	610	1416	20
RUAG	Switzerland	A Ac Eng SA/A	540	3124	55
Ultra Electronics	UK	El	530	2272	76
Avio	Italy	Eng	500	1355	28
Thales Nederland (Thales, France:S)	Netherlands	El	500	NA	100
Santa Barbara Sistemas	Spain	A MV	500	1980	100

General Dynamics, USA:S)		SA/A			
Patria	Finland	Ac MV SA/A	480	2082	85
Meggitt	UK	Oth	480	2496	39
Kongsberg Gruppen	Norway	El Mi SA/A	450	1570	43
Elettronica	Italy	El	440	800	100
Selex Sistemi Integrati (Finmeccanica: S)	Italy	Comp (El)	440	1700	59
MBDA Italia (MBDA, Europe: S)	Italy	Mi	440	1410	100
Fiat	Italy	MV	430	1720	1
Iveco (Fiat:S)	Italy	MV	430	981	4
Oto Melara (Finmeccanica: S)	Italy	A MV Mi	430	1360	100
Average size of top 10 EU firms		3.1	6172	24475	52
Average size of all EU firms shown in Table (excluding subsidiaries)		2.1	2495	10232	51

Notes:
i) Companies ranked by the value of their arms sales in current prices and exchange rates. Company names and structures are listed as they were at end-December, 2005.
ii) S=subsidiary; A= artillery; Ac= aircraft; El=electronics; Eng= engines; Mi=missiles; MV=military vehicles; SA/A= small arms/ammunition; Sh= ships; Sp= space; Oth= other; Comp (..) = components, services or any item less than final system in the sectors shown in parentheses.
iii) MBDA established in Dec 2001 through mergers of Matra BAe Dynamics, EADS-Aerospatiale Matra Missiles and the missile activities of Alenia Marconi Systems.
iv) BAE Systems and Rolls-Royce owned a number of US subsidiaries.
v) Arms employment company data are estimates based on the share of arms in total sales applied to total employment.
vi) European firms are those in the SIPRI top 100 arms companies in the world.

Source: **SIPRI Yearbook 2008**, Stockholm International Peace Research Institute and Oxford University Press, Oxford.

The European Defence Industrial Base, 1990

7. Europe's defence industrial base has developed over a considerable period. For our purposes, it is sufficient to take 1990 as a basis for an historical comparison. The Cold War ended by 1990 and this was followed by disarmament and major industrial re-structuring involving exits, mergers, plant closures and job losses. Table 3 shows the European defence industrial base in 1990. This Table shows all European firms listed in the SIPRI top 100 arms producers in the OECD and developing countries in 1990 (Table 2 is based on the top 100 arms producing companies in the world, excluding China).

Table 3. Top European Arms Companies, 1990

Company	Country	Sector	Arms sales (US$ millions)	Arms employment	Arms sales as share of total sales (%)
British Aerospace	UK	Ac, A, El, Mi, SA/O	7520	51160	40
Thomson SA	France	El, Mi	5250	40090	38
Thomson-CSF (Thomson SA:S)	France	El, Mi	5250	36113	77
GEC	UK	El	4280	29632	25
Daimler Benz	Germany	Ac, Eng, MV, Sh	4020	30144	8
DCN	France	Sh	3830	30500	100
DASA (Daimler Benz:S)	Germany	Ac, Eng, El, Mi	3720	29412	48
Aerospatiale	France	Ac, Mi	2860	16584	44
IRI	Italy	Ac, Eng, El, Sh	2670	132010	36
Dassault Aviation	France	Ac	2260	9685	65
Alenia(IRI:S)	Italy	Ac, El, Mi	1840	13189	60
Rolls-Royce	UK	Eng	1830	18452	28
CEA Industrie	France	Oth	1810	12474	33
EFIM	Italy	Ac, MV, El	1710	29307	79
INI	Spain	Ac, A, MV, El, Sh, SA/O	1560	13196	9
SNECMA Groupe	France	Eng	1490	9389	34
GIAT Industries	France	A, MV, SA/O	1430	14550	97
MBB (DASA:S)	Germany	Ac, El, Mi	1420	11615	50
FIAT	Italy	Eng	1180	51550	17
Matra Group	France	Mi, El, Oth	1180	6330	26
MTU (DASA:S)	Germany	Eng	1110	8762	50
Oerlikon-Buhrle	Switzerland	Ac, A, El, SA/O	1080	8460	32
Bremer Vulkan	Germany	Sh	1050	4807	44
Siemens	Germany	El	990	11190	3
Nobel Industries	Sweden	El, Mi, SA/O	930	5331	20

VSEL Consortium	UK	MV, Sh	930	15464	100
Matra Defense (Matra:S)	France	El, Mi, Oth	920	NA	99
Diehl	Germany	A, MV, El, SA/O	860	7252	48
CASA (INI:S)	Spain	Ac	780	8141	81
Oto Melara	Italy	A, MV, Mi	780	2245	100
Rheinmetall	Germany	A, SA/O	750	5765	41
Eidgenossische Rustungsbetrietebe	Switzerland	Ac, Eng, A, SA/O	700	4438	95
Telefunken System Technik (DASA:S)	Germany	El	680	6092	65
SNECMA (SNECMA Groupe:S)	France	Eng	650	3521	25
Lucas Industries	UK	Ac	630	8241	15
Bofors (Nobel Industries: S)	Sweden	A, El, Mi, SA/O	620	4276	94
SAGEM Groupe	France	El	570	4525	28
Agusta (EFIM: S)	Italy	Ac	560	4870	60
Dassault Electronique	France	El	530	3118	72
Westland Group	UK	Ac	510	6762	69
FFV	Sweden	A, El, SA/O, Oth	500	4563	47
Dornier (DASA: S)	Germany	Ac, El, Mi	500	3061	28
Smiths Industries	UK	El	490	5371	41
Hollande Signaal (Thomson-CSF:S)	Netherlands	El	490	4296	95
Racal Electronics	UK	El	480	5000	13
Hawker Siddeley	UK	El	480	5352	12
Systemtechnik Nord (Bremer Vulkan:S)	Germany	El	470	1798	75
Devonport Management	UK	Sh	470	7465	94
E.N. Bazan (INI:S)	Spain	Sh	460	8363	87
FIAT Aviazione (FIAT:S)	Italy	Ac, Eng	460	2566	55
SAAB-SCANIA	Sweden	Ac, Eng	450	2603	8
Dowty Group	UK	Ac, El	450	4957	33
Thorn EMI	UK	El	450	4055	7
Ferranti-International Signal	UK	El	440	5576	54
Hunting	UK	SA/O	420	2145	31

Mannesmann	Germany	MV	410	3720	3
Krauss-Maffei (Mannesmann:S)	Germany	MV	410	2542	47
Sextant Avion (Thomson-CSF/Aerospatiale:S)	France	El	400	3295	36
Lurssen	Germany	Sh	400	875	81
SAGEM (SAGEM Groupe:S)	France	El	390	2621	41
Average size of top 10 EU firms		3.1	3633	37073	27

Notes:
i) In 1990, Germany was the Federal Republic of Germany.
ii) See Notes to Table 2.

Source: SIPRI Yearbook, 1992.

8. Table 3 has some distinctive characteristics:

i) In 1990, there were 41 European firms in the SIPRI top 100 (excluding subsidiaries).

ii) There were 22 European single product firms (54% of all European firms, excluding subsidiaries). These were in aero-engines, aircraft (including helicopters), electronics, land systems and shipbuilding. Significantly, electronics firms dominated the list of European single product firms (accounting for 9 of the 23 single product firms). In 1990, INI and BAe were involved in the largest number of product areas, namely 5 to 6 sectors.

iii) There were only three firms which were 100% defence-dependent DCN; VSEL; Oto Malara) and two of these were warship builders. A further 12 firms (including subsidiaries) had arms sales accounting for 75% - 99% of total sales.

A Comparison of European Defence Companies 1990 and 2006.

9. Over the period 1990 to 2006, new names emerged in the top European arms firms reflecting mergers and acquisitions (eg. BAE Systems; EADS; Thales). Most European mergers and acquisitions occurred at the national level leading to the creation of national champions. However, there were a few notable cross-border European mergers and acquisitions, namely, EADS and Thales. BAE Systems adopted a different business strategy leading to major acquisitions in the US defence market. Elsewhere in Europe, other firms either dropped out of the top group or exited the industry. Noticeable changes affected the UK defence electronics industry (e.g. BAE acquired GEC (Electronics); Thales acquired Racal). Despite the changes in names, BAE Systems remained the EUs largest arms company throughout the period. It also acquired a number of US companies, including United Defense (military vehicles).

10. Other changes between 1990 and 2006 included:

i) By 2006, Europe accounted for a smaller number of the world's top 100 arms companies.

ii) There was a rise in the number of defence-dependent arms companies: from 15 in 1990 to 20 in 2006 (including subsidiaries with arms accounting for 75%-100% of total sales).

iii) In 2006, the top three EU defence companies were involved in more arms product fields: almost an average of 6 sectors for the top 3 in 2006 compared with an average of 3 sectors in 1990. Thus, the largest firms were increasingly multi-product defence companies.

iv) Private equity groups (financial investors) have entered the defence industry (e.g. Carlyle Group, USA; Cinven, Europe: BIPE, 2008). For example, in 2003, the Carlyle Group purchased a majority interest in QinetiQ (the UKs privatised research firm) and subsequently sold its interest in 2006.

Comparisons with the US Defence Industry

US companies, 2006

11. Table 4 shows the main features of the top 10 US arms companies in 2006 (two subsidiaries are shown). There are some distinctive features:

i) The top 3 firms are multi-product aerospace firms involved in 4-5 arms sectors. Most of the remaining firms in the top 10 were involved in 1-2 sectors (e.g. electronics; engines; components).

ii) No firm was 100% defence-dependent (apart from the BAE subsidiary), but six firms had defence sales of 70% or more of total sales (Lockheed Martin; Northrop Grumman; Raytheon; GD; L-3; SAIC).

iii) Three of the firms in the top 10 were US military service companies (Halliburton; SAIC; Computer Services Corp) illustrating how private firms have responded to new market opportunities (e.g. military outsourcing and work in Iraq). Also, some other US military service companies have entered the SIPRI top 100 list (e.g. EDS).

Table 4. Top 10 US Arms Companies, 2006

Company	Sector	Arms sales (US$ millions)	Arms employment	Arms sales as share of total sales (%)
Boeing	Ac El Mi Sp	30690	77000	50
Lockheed Martin	Ac El Mi Sp	28120	99400	71
Northrop Grumman	Ac El Mi Sh Sp	23650	95316	78
Raytheon	El Mi	19530	76800	96
General Dynamics	A El MV Sh	18770	63180	78

BAE Systems Inc (BAE Systems, UK:S)	A El MV SA/A	11280	51700	100
L-3 Communications	El	9980	50960	80
United Technologies Corp (UTC)	El Eng	7650	34320	16
Halliburton	Comp (Oth)	6630	30160	29
KBR (Halliburton:S)	Comp (Oth)	6630	38640	69
Computer Sciences Corp	Comp (Oth)	6300	33180	42
SAIC	Comp (Oth)	5800	30800	70
Average size of top 10 firms	2.5	15712	59112	61

Notes:
i) Averages exclude subsidiaries.
ii) See Table 2.

Source: SIPRI (2008)

US companies, 1990

12. There have been major changes since 1990. Table 5 shows the top US arms companies in 1990. There were major structural changes in the US defence industry between 1990 and 2006. Boeing acquired McDonnell Douglas and Rockwell; Lockheed and Martin Marietta merged and also acquired the military aircraft division of General Dynamics and the military business of Loral; Northrop and Grumman merged and acquired TRW and Newport News; and Raytheon acquired Hughes Electronics, Chrysler Electronics Systems, GD Missile Systems, E-Systems and the Defence and Electronics Group of Texas Instruments.

Table 5. Top 10 US Arms Companies, 1990

Company	**Sector**	**Arms sales (US$ millions)**	**Arms employment**	**Arms sales as share of total sales (%)**
McDonnell Douglas	Ac El Mi	9020	66660	55
General Dynamics	Ac MV El Mi Sh	8300	80442	82
Lockheed	Ac	7500	54750	75
General Motors	Ac Eng El Mi	7380	45684	6
Hughes Electronics (General Motors:S)	Ac El	6700	54720	57

General Electric	Ac Eng	6450	32780	11
Raytheon	El Mi	5500	43719	57
Boeing	Ac El Mi	5100	29106	18
Northrop	Ac	4700	32852	86
Martin Marietta	Mi	4600	46500	75
United Technologies	Ac El Mi	4100	36594	19
Average all top 10	2.5	6265	46909	22

Notes: See Table 2**.**

Source: SIPRI (1992)

13. The general features of the top 10 US companies in 1990 were:

i) The top 3 were aerospace companies involved in one to five sectors with an average of 3 sectors.

ii) No firms in the top 10 were 100% defence-dependent and there were four firms with defence sales of 75% to 86%.

iii) Only three firms in the top 10 were single product arms firms (two in aircraft and one in missiles). The rest were multi-product arms companies.

Time-series and international comparisons, 1990-2006

14. Questions arise about the relative size of EU and US arms firms over time and the data are shown in Table 6. The Table shows the following:

i) Between 1990 and 2006, European and US arms firms generally increased in size both in terms of sales and employment.

ii) However, relative size trends are more indicative of international competitiveness. In terms of sales, the relative size of the top US firm compared with the top EU firm remained broadly constant and unchanged. But the relative size of the top 10 firms changed markedly. Over the period 1990 to 2006, the US top 10 firms increased their size advantage substantially over the equivalent group of EU firms (based on arms sales). Arms employment data show a different trend in relative terms; but these data are based on broad estimates and do not reflect productivity.

iii) The broad conclusion of Table 6 is that the *top* EU firm is reasonably comparable with the *top* US firm. **However, the top 10 EU arms firms show the opportunities for further European re-structuring to create larger arms firms capable of competing with the US top 10 arms companies**. ***Applying US scales of output suggests that the current EU top 10 could be reduced to some four EU arms firms***. Such a conclusion is subject to the usual qualification about correlation and causation, namely, that larger size of firm does not guarantee a successful competitor.

iv) Over time, arms companies have generally become more defence-dependent. The exception appears to be the top US firm in 2006: this is Boeing which has a major civil airliner business. In fact, the 2nd and 3rd ranked US arms companies – Lockheed Martin and Northrop Grumman – had defence-dependencies of 71% and 78%, respectively in 2006. Also, the top 10 US firms in 2006 were substantially more defence-dependent than their European equivalents (61% compared with 52% in 2006).

v) Mergers and acquisitions have increased industry concentration. Most European national defence markets are characterised by domestic monopolies for major air, land and sea systems. Examples include BAE Systems in the UK, Thales (electronics), DCN (naval) and Nexter (formerly GIAT: land) in France; Finmeccanica in Italy and Saab in Sweden. In contrast, the US defence market is dominated by domestic oligopolies (Boeing; Lockheed Martin; Northrop Grumman). Overall, concentration has risen amongst the top 100 arms companies. In 1990, the world's top 5 arms firms accounted for 22% of the world's top 100 arms sales; by 2005, this figure had doubled to 44% (BIPE, 2008). Similarly, between 1990 and 2005, the largest defence firm increased its share of the top 10 arms sales from 13.5% to 16% (and the largest firm changed from McDonnell Douglas in 1990 to Boeing in 2006: Hartley, 2007a). Whilst these are non-conventional measures of concentration, they are indicative of the general trend towards increased concentration.

Table 6. Firm comparisons, 1990 - 2006

Comparator	**1990**	**2006**
Absolute size: arms sales (US$ 2006 prices)		
Top EU firm	11638	24060
Top US firm	13960	30690
Top 10 EU firms	5623	6172
Top 10 US firms	9696	15712
Absolute size: arms employment		
Top EU firm		
Top US firm	51160	84170
Top 10 EU firms	66660	77000
Top 10 US firms	37030	24475
	46909	59112
Relative size: arms sales (US$ 2006 prices)		
Top US firm to top EU firm	1.2	1.28
Top 10 US firms to top 10 EU firms	1.72	2.55
Relative size: arms employment		
Top US firm to top EU firm	1.3	0.92
Top 10 US firms to top 10 EU firms	1.27	2.4

Defence-dependency (arms as share of total sales:%)		
Top EU firm		
Top US firm	40	95
Top 10 EU firms	55	50
Top 10 US firms	27	52
	22	61

Notes:
i) Sales data are in constant 2006 prices based on US consumer price index 1990-2006.
ii) Data for Top 10 firms are averages.

Scale and Learning Economies

15. Scale and learning economies lead to decreasing unit costs and result in decreasing cost industries. Such economies will determine firm size, reflecting the unit cost advantages and hence price competitiveness of larger size. Learning curves are a major source of productivity improvements in the aerospace industry; and learning economies have been identified in other defence industries (Sandler and Hartley, 1995; Hartley and Sandler, 2001). Traditionally, learning was associated with aircraft production and learning curve slopes of 75% to 80%. For other defence industries such as aero-engines, electronics, missiles, main battle tanks and warships learning curve slopes of 75% to 96% have been estimated (Hartley, 2007a). However, whilst labour learning remains important it has been affected by modern manufacturing methods and business practices involving new materials, computer-aided design and manufacturing, lean methods, and assemblies arriving for final assembly already 'pre-packed' so that components and avionics do not have to be installed during final assembly. The traditional 80% learning curve was established in pre-computer-aided manufacture days (CAM). The curve with CAM is much less than that of manual labour: the benefit of CAM is that the starting cost can be lower due to the reduced man hour input (Flight, 2008, p89). As a result, typical learning curves for European aerospace companies are now 85% to 90% compared with the traditional 80% curve. Moreover, European aerospace firms are now achieving continuous learning on military and civil aircraft projects (e.g. especially on Airbus civil jet airliners which have achieved US scales of output) compared with the 1950s/1960s experience of 'flat' learning curves at some 100 units (at that time, US experience showed continuous learning: Hartley, 2007a).

C. Market Conduct

16. Market conduct refers to price and non-price competition. Imperfect markets are characterised by non-price competition, comprising equipment quality (performance characteristics), R&D, advertising, marketing and political lobbying. Defence market conduct is determined by government procurement agencies which specify the rules of competition for contract awards. Price competition is often confined to production work, repair, maintenance and modifications where the risks are relatively low and *fixed price contracts* are awarded. Such contracts provide efficiency incentives to contractors since if they deliver the equipment at less than its estimated cost, the contractor receives all the cost savings. Fixed price contracts can be determined by competition or by direct negotiation (negotiated prices will require accurate estimates of costs and of profitability, otherwise contractor profits might reflect poor and inaccurate estimating). A genuine competition will determine both prices and profits and provide an efficient outcome. However, most EU defence markets for large, complex

equipment projects are imperfect, dominated by national monopolies some of which are state-owned.

17. Price is less reliable as an efficiency indicator at the early stages of project development where risks are high and can be unknown. For such R&D work, contracts are usually priced on the basis of costs using either *cost-plus or target cost incentive fee* contracts where substantial risks are borne by government rather than the contractor. Cost-plus contracts offer the contractor little, if any, efficiency incentives (they have been known as 'blank cheque' contracts: Sandler and Hartley, 1995, chp 5). Overall, the type of contracts awarded by procurement agencies will determine contractor efficiency. Fixed price contracts awarded on the basis of a genuine competition will promote efficiency whilst cost-based contracts, especially cost-plus contracts, will lead to contractor inefficiencies reflected in labour hoarding, especially of scientists and technologists, project cost escalation, delays in delivery and poor quality performance in relation to the contract specifications (e.g. gold-plating).

18. Where price is an unreliable indicator of contractor efficiency, procurement agencies resort to other indicators to assess contractor performance. These include such non-price indicators as project performance (e.g. speed/range of combat aircraft and UAVs) which provides contractors with incentives to emphasise R&D and innovation (hence, contractors will recruit scientists and technologists to provide them with a competitive advantage where contract awards are based on the technical quality of a proposal). Contractors will also use other mechanisms to influence procurement agencies to favour them in contract awards. These include advertising, marketing, sales promotion efforts as well as political lobbying, all of which are designed to win the contract. Inevitably, there are opportunities for 'side payments' and corruption in such markets (such behaviour is likely in all markets where there are large government contracts) with the associated need for public scrutiny and transparency for such contracts. Large monopoly defence contractors form potentially powerful interest groups in the defence-political market. Data on such firms was provided in Section B on Industry Structure.

19. Some limited published data are available on aspects of market conduct in EU defence markets. For example, the UK publishes annual data on contract awards by type of contract as well as annual reports on cost escalation and delays in delivery. There are also data on R&D by major EU defence companies.

20. Table 7 shows UK data on contract awards by type and by the extent of competition. Over the period 1990 to 2007, there was an increase in the proportion of contracts priced by competition (although there was a peak of 70% in 2003/04 and a decline in 2007/08). Similarly, the share of non-competitive contracts declined from 37% in 1990/91 to 31% by 2006/07; but then rose to an high of 53% in 2007/08 (probably reflecting domestic monopolies and the UKs Defence Industrial Strategy). Significantly, cost-plus contracts have apparently been eliminated from UK contract awards whilst incentive fee contracts declined to 2007 and then rose significantly in 2007/08. The UKs adoption of its Defence Industrial Strategy with long-term partnering agreements with 'key' defence firms is likely to mean a rise in the role of non-competitive contracts. **Similar data to those shown in Table 7 for pMS would be a useful indicator of EU market conduct.**

Table 7. UK Defence Contracts by Type

Contract Type (Percentage of total value)	**1990/91**	**2000/01**	**2006/07**	**2007/08**
Contracts priced by competition	44	56	62	36
Contracts priced by reference to market forces	19	9	7	11
Contracts priced on estimates at outset or soon after	23	21	22	29
Contracts priced on actual costs with incentives to minimise costs	13	14	9	24
Contracts priced on actual costs plus a % fee	1	0	0	0

Notes:
i) Contracts priced by reference to market forces includes use of informal competitive tendering and commercial price lists.
ii) Contracts priced on estimates, actual costs and percentage fee are priced by reference to Government profit formula for non-competitive contracts.

Source: MoD/DASA, **UK Defence Statistics 2007 and 2008,** Ministry of Defence, London

21. Market conduct is likely to be reflected in equipment costs, including R&D costs and in cost trends. The UK and USA are amongst the few nations which publish data on cost escalation and delays in delivery on major defence projects. There are though some general data on defence equipment costs based on a sample of European and US equipment projects. The data on cost levels and cost trends are summarised in Table 8 where it can be seen that modern defence equipment projects are costly and the cost trends are upwards. Maintaining modern, well-equipped Armed Forces is not cheap and costs are rising from a range of 1% to 10% per year. There are also data on the relationship between development and production costs. For example, for fighter/strike aircraft, the ratio of development to unit production costs is 200 (including a new engine); for an helicopter, the corresponding ratio is 120; for armoured fighting vehicles it is 250 and for air-to-surface guided weapons it is 6500 (Pugh, 2007). High ratios of development to unit production costs show the importance of quantity production in 'spreading' and recovering high 'fixed' R&D costs. They also illustrate the importance of R&D for modern defence equipment and its impact on market conduct. Of course, nations can seek to economise on costly R&D by collaboration with other nations. Typically, collaboration leads to higher development costs, possibly of the order of an extra 50% for each participating nation beyond the first nation (Pugh, 2007, p87).

Table 8. Examples of Equipment Costs

Type	**Level of costs (£, 2006 prices**	**Annual rate of cost increase (%)**
Aircraft carrier (100000tons)	5.5 billion (acq)	3
Air defence vessel	640 million (acq)	2
Nuclear-powered submarine (SSN)	1.3 billion (acq)	1
Main battle tank	4 million (upc)	1
Fighter/strike aircraft	70 million (upc)	4
Attack helicopter	24 million (upc)	5
Reconnaissance UAV	5 million (upc)	6
Bomber aircraft	2.5 billion (upc)	10

Notes: acq= acquisition costs; upc= unit production cost
Source: Pugh, P (2007). **Source Book of Defence Equipment Costs**, Pugh, Clapham, Bedford, UK.

22. Published data are available for R&D as another indicator of market conduct. However, these data are for a group of aerospace and defence firms and do not show separate data for defence R&D. Nonetheless, they are a broad indicator which can be used to assess R&D conduct in the EU defence market. The R&D data are shown in Table 9. Interestingly, on the basis of total R&D spending in 2007, there were equal numbers of EU and US firms in the top 16. Also, the top EU firms recorded higher shares of both R&D and R&D plus capital spending than the top US firms. These results *appear* surprising in view of the US defence industry's international competitive advantage, especially in high technology equipment. **However, the R&D data are subject to a major limitation**. The R&D data in Table 9 are based on that disclosed in the company's annual reports and accounts and is subject to accounting definitions of R&D (i.e. privately-funded R&D, much of which is for civil R&D). Also, with international comparisons, some international companies follow the US practice of including engineering costs related to product improvement so that definitions might differ. More importantly, the R&D data in Table 9 excludes R&D undertaken for customers such as governments and other companies; it also excludes the company's share of any associated company or joint venture; but joint ventures are listed as companies. **Thus, the R&D data in Table 9 exclude a major component of defence R&D, namely, that funded by government** (DTI, 2007, **The Value Added Scoreboard**, volume 2, p188, London). A rank correlation between total R&D spending and company size measured by sales gave a significant and positive correlation of 0.765 (Tables 9 and 10 data). Another rank correlation was estimated between total R&D and company profitability giving a negative correlation of –0.45 which was not significant; and the rank correlation between R&D as a share of sales and profits as a share of sales was positive at 0.121 but not significant (Tables 9 and 10).

Table 9. R&D Conduct in Top EU and US Aerospace and Defence Companies, 2007

Company	**Total R&D (£million)**	**R&D as % of sales**	**R&D and capital expenditure as % of sales**
EADS	1933.0	7.3	13.1
Boeing	1664.1	5.3	8.0
Finmecc-anica	1259.3	16.1	20.9
BAE Systems	1248.0	10.1	14.3
United Techn-ologies	781.2	3.2	5.2
Lockheed Martin	581.95	3.4	6.0
Rolls-Royce	411.0	5.7	10.0
Thales	348.3	5.0	7.3
SAFRAN	299.8	4.1	7.7
Northrop Grumman	293.3	1.9	4.3
Raytheon	237.1	2.0	3.3
General Dynamics	192.6	1.6	2.9
Dassault Aviation	190.3	8.6	11.9
Goodrich	183.9	6.1	10.5
Rockwell Collins	142.6	7.2	11.0
SAAB	94.7	6.0	8.1

Notes:
i) Companies ranked by total R&D spending based on top 1250 global companies. Table shows the top 16 firms only.

Source: BEER, **The 2007 R&D Scoreboard**, Department for Innovation, Universities and Skills, London

D. MARKET PERFORMANCE

23. There are some standard economic indicators of market performance, including productivity, profitability and exports reflecting international competitiveness. Admittedly, there are limitations and qualifications when using these indicators. For example, labour productivity measures reflect total sales, including bought-out components, as well as failing to correct for capital inputs. Profitability might reflect a monopoly position and hence monopoly profits rather than efficiency; and exports might reflect political influence rather than international competitiveness. This section evaluates evidence on productivity, profitability and exports, including the limitations of the data (a later section addresses the general issue of the reliability of the data in this field).

Productivity

24. Two measures are reported, namely, labour productivity for a group of aerospace and defence companies in Europe and the USA and data on value added productivity for a group of European aerospace and defence firms (see Table 10). Comparisons are possible between companies and with the industry averages and the averages for all companies. Within the top 16, labour productivity varies substantially with the highest figures for EADS and Boeing each with large-scale production and sales of civil aircraft. More relevant comparisons are between BAE Systems, Lockheed Martin and Northrop Grumman as defence-dependent companies. Here, BAE has a substantially higher labour productivity than either of the US defence companies. The all companies composite is an indicator of the alternative use value of resources. On sales per employee, only EADS amongst the European group exceeds the all companies composite. However, using the more accurate indicator of labour productivity, namely, value added, then the aerospace and defence group has a higher value added per person than the all companies composite, suggesting a superior use of resources. Such comparisons are suggestive rather than conclusive. They are subject to all the standard data limitations, especially the lack of specific company defence data on variables such as labour and value added productivity; and the need for time-series analysis before reaching conclusions. Rank correlations were estimated between each of sales and labour productivity and employment and labour productivity (sales per employee), resulting in estimated correlations of 0.33 and 0.28, respectively, neither of which were significant. In contrast, there was a significant and positive correlation between sales and employment (all rank correlations based on data in Table 10, with n=16; t=3.36 for sales/employment correlation).

Profitability

25. Profitability is a standard indicator of company performance. Again the published data are for total company profits based on total sales and not the defence component. Nor can one year's observation be used to assess a company's future financial viability. In addition, the capital market usually assesses a company's performance by both profitability and its share prices (e.g. in relation to the value of the company). Table 10 shows data on profits as a share of company sales. European figures range from losses to a maximum of almost 10% with a median of 7%; whereas US profitability ranges from some 6% to 18% with a median of 10-11%. Also, the European aerospace and defence group returned substantially lower profitability than the all companies composite which raises questions as to why firms remain in the European aerospace and defence industry. The rank correlation between total company sales and profitability (profit share of sales) was –0.15 which was not significant. Finally, there was some tentative evidence that state-owned enterprises (Finmeccanica; Thales; Safran) achieved lower profitability than privately-owned firms. In Table 10, the European privately-owned firms achieved a median profit rate on sales of 7.9% compared with a median profit rate of 5.5% for the European state-owned firms (but with such limited data, this conclusion is suggestive only).

Exports

26. Table 10 presents some limited information on the share of company sales outside the home region (exports). A rank correlation between profitability and export shares for those companies reporting data in Table 10, gave a rank correlation of –0.41 which was not statistically significant (t = 1.35). A similar rank correlation between export

shares and labour productivity (sales per employee) gave a positive correlation of 0.43 but this also was not significant (Table 10 data).

Table 10. Market Performance of Top Aerospace and Defence Firms, 2007

Firm	**Sales (£mn)**	**Employ-ment**	**Sales per employee (£000s)**	**Value added per employee 2005/06 (£000s)**	**Profitability (profits as % of sales)**	**Sales outside home region (%)**
EADS	26569	116805	227.5	75.0	0.3	56
Boeing	31438	154000	204.1	NA	5.6	NA
Finmeccanica	7832	56653	138.2	52.3	6.8	28
BAE Systems	12333	79000	156.1	67.2	7.9	64
United Technologies	24437	214500	113.9	NA	12.8	NA
Lockheed Martin	17302	140000	123.6	NA	11.0	NA
Rolls-Royce	7156	37300	191.9	77.2	9.7	71
Thales	6916	52160	132.6	55.3	5.5	35
SAFRAN	7304	57669	126.7	32.2	-2.0	46
Northrop Grumman	15483	122000	126.7	NA	8.4	NA
Raytheon	11891	80000	148.6	NA	9.2	29
General Dynamics	12371	81000	152.7	NA	11.9	14
Dassault Aviation	2225	12057	184.5	76.5	11.3	NA
Goodrich	3003	23400	128.4	NA	9.9	44
Rockwell Collins	1974	18600	106.1	NA	18.0	27
SAAB	1573	12858	122.3	58.1	7.2	35
All Aerospace and Defence	222589	1539679	144.2	60.4	7.7	NA
All Companies composite	7002556	34.9 million	193.8	56.7	11.8	NA

Notes: NA is not available. Value added data were only published by DTI for top UK and European companies. Company ranking based on ranking in Table 9.
Sources: BEER, **The 2007 R&D Scoreboard**, London; DTI, **The Value Added Scoreboard, 2007**, Department of Trade and Industry, London.

27. Arms export data are available annually by nation and data for 2007 are shown in Table 11. These data are for actual deliveries of major conventional weapons and are presented using the SIPRI trend indicator values (TIVs) expressed in US$ million at constant 1990 prices. *TIVs do not represent the financial values of arms exports: they show the volume of arms transferred.* However, TIVs can be used to measure trends in

international arms transfers, but they are not comparable to official economic data such as GDP or export/import data. Nonetheless, the data indicate the dominance of the USA accounting for 30% of the world market, as well as identifying the major EU arms exporters, namely, Germany, France, Netherlands and the UK, each of which has considerably smaller arms exports than the USA. Data for the *value* of arms exports result in a different country ranking. Aggregate arms exports for European nations for the period 1998-2004 using value figures showed a ranking of the UK as first, followed in rank order by France, Germany, Belgium, Sweden, the Netherlands and Italy (SIPRI Yearbook, 2006; also EU (2007)).

Table 11. European and US Arms Exports by country, 2007

Nation	**Arms Exports (US$ m at constant 1990 prices: trend indicator values)**
USA	7463
Germany	3438
France	2940
Netherlands	1355
UK	1151
Italy	562
Spain	529
Sweden	413
Switzerland	211
Poland	135
Austria	86
Portugal	30
Finland	24
Romania	16
Czech Republic	13
Belgium	10
Bulgaria	7
Hungary	6
Denmark	5
Greece	0
Norway	0
Slovakia	0
Total for 50 largest exporters in world	24520

Note: Export data based on trend indicator values: see SIPRI for definition
Source: SIPRI Arms Transfer Project: data base (March, 2007)

E. The Porter Model

28. Porter's five forces model of the firm's competitive environment is developed from the SCP model. The five forces are:

- The threat of new entrants. The emphasis is on the threat of entry or the contestability of markets.

- The threat of substitute products or services.
- The bargaining power of suppliers.
- The bargaining power of buyers.
- The rivalry amongst existing competitors.

29. The strength of the five forces varies between industries and determines long-run industry profitability. For example, the threat of new entry limits an industry's profit potential and its ability to act as a monopoly; where there are large numbers of similar-sized firms in an industry, then fierce competitive rivalry erodes profits; and powerful buyers can reduce monopoly profits. In the Porter model, the strength of each of the five competitive forces is determined by industry structure.

30. The Porter model has obvious applications to EU defence markets. Proposals to create an EDEM provide greater opportunities for rivalry amongst existing competitors, as well as increasing the threat of new entry and the possibility of substitute products and services. However, the trend towards larger defence firms with greater market power will increase the bargaining power of suppliers in contract negotiations. National monopolies raise challenges for procurement agencies in negotiating prices and profits which provide efficiency incentives. Faced with larger and possibly international defence firms, national governments will be confronted with reduced bargaining power in relation to such suppliers. Governments might respond by creating EU-wide procurement agencies which will improve their bargaining power as buyers.

F. Analysing the Change Drivers

31. Trends and changes in the size, structure, conduct and performance of the EU defence industrial base reflect the role of major change drivers. Inevitably, there are links and overlaps between the various drivers. Ranked by their importance (weights are illustrative), the major change drivers comprise:

i) Defence budgets (financial pressures) with a weighting of 50-60%

ii) Market pressures with a 30% weight

iii) Technological pressures with a weight of 10-20%; and

iv) Other pressures with a weight of 10%.

Defence budgets: financial pressures

32. Defence budgets and likely future budget reductions are the largest single driver of change in the EDTIB. At its simplest, governments are defence markets. The size of the defence budget determines the allocation for equipment procurement which, in turn, determines the spending on R&D, production and spares. These budget items determine the demand for equipment. Without a budget, there will be no demand: hence, no market and therefore, no national defence industrial base. Even with a procurement budget, there is no guarantee that government will prefer to support its national defence industrial base (it might prefer to import defence equipment). The

impact of defence spending on national defence industries is shown in Table 1 where there were major employment reductions between 1990 and 2003.

33. Future defence budget reductions in real terms are most likely. Identifying the defence budget as a major driver also reflects economic and political pressures (e.g. the 2008 economic crisis) and preferences for social welfare spending. Pressures on the defence budget will further impact on political factors favouring the creation of an EDEM which offers genuine efficiency savings in defence equipment procurement. There is a further link to new threats and new technology. New threats will lead to changing demands (and hence pressure for higher budgets) from the Armed Forces and similar demands are likely to arise from new technology. For example, consider the impact of UCAVs on each of the Armed Forces (e.g. replacing manned combat aircraft; impact on training requirements). In other words, political pressures, threats and technology are reflected in financial pressures as expressed in defence and procurement budgets.

34. In the Porter analysis, defence budgets determine the bargaining power of the government as a major buyer and will further determine the bargaining power of sellers (Porter, 1990). Reductions in defence procurement budgets mean smaller national defence industries and governments with greater bargaining power; in these circumstances, sellers lose some of their bargaining power (but private firms retain the power to exit the defence industry). Relative bargaining power will affect prices and profits: where governments are powerful bargainers, they can 'squeeze' contractor prices and profit margins.

Market pressures

35. For privately-owned defence firms, profits are the major market driver. A lack of profits means exits. Privately-owned defence firms will seek profitable opportunities by economising on transaction costs. As a result, various alternative forms of firm organisation will develop reflecting different views on future markets, their risks and the form of the business organisation which will minimise transaction costs. On this view, a comparison of Boeing/EADS with BAE Systems/Lockheed Martin reveals alternative business models of the defence firm. Boeing/EADS are aerospace defence firms with a substantial civil business, including major markets for large civil aircraft. In contrast, BAE/Lockheed Martin are defence specialists with an involvement in air, land, sea and electronics markets. Each business model reflects different approaches to risk-bearing and to economising on transaction costs. The result of these alternative models has been reflected in mergers and acquisitions in both the EU and the USA, leading to some 'new' company names and some cross-border acquisitions (e.g. EADS; BAE acquisition of US defence companies: see Tables 2-5 and Bacri (2004)).

36. Industrial re-structuring reflected market pressures with some new entry and some exits from the defence sector each showing applications of Porter's analysis of rivalry from existing competitors and from new entrants and from substitute products. New entry included some new UAV companies (with UAVs as substitute products for manned combat aircraft) as well as new firms entering the military outsourcing market (e.g. private contractors providing air refuelling capability to the UK RAF; US private contractors in Iraq). Increasingly, there will be an emphasis on firms providing services rather than equipment, with such services both provided and financed by the private sector. Defence firms will adopt various strategies for responding to risks and to new market opportunities reflecting new threats. Firms will diversify their risks by

entering new defence and/or civil markets and will respond to new market opportunities through new entry or through mergers/acquisitions. For example, traditional defence firms will respond to the new terrorist threats and the focus on homeland security by acquiring firms already established in these markets or by applying and developing some of their existing technology to the homeland security market (e.g. defence electronics firms developing equipment for protecting airliners from missile attacks; and developing screening devices for use in railway stations and underground systems). **As a result, the future defence firm will be different**. The defence firm of 2050 will be radically different from today's defence firms just as today' defence firms differ from those of 1940 and those of 1900 (e.g. Boeing, EADS and BAE did not exist in 1900).

37. For private firms, the structure of defence firms and industries will be determined by national and international capital markets and the extent to which national governments allow free capital markets in defence industries. Again, governments are key through their willingness to allow foreign firms to acquire national defence companies. The UK, for example, allows European and US defence firms to acquire UK defence companies (e.g. Finmeccanica; Thales; Lockheed Martin; General Electric). Similarly, the US has allowed UK defence firms to acquire US defence companies (e.g. BAE Systems; Rolls-Royce). In addition to possible government constraints on the operation of private capital markets, further constraints arise where there are state-owned defence firms. Typically, such firms are inefficient with 'soft' budget constraints and objectives which are specified by governments (e.g. including job protection and regional development). As state-owned companies, they are not subject to threats of take-over or bankruptcy. Future trends are likely to be towards the privatisation of such state-owned European defence companies.

38. Again, government can determine industry structure by supporting or opposing mergers, by allowing or opposing new entry and by allowing or opposing exit (e.g. bail-out of national champions). Both the EU and the USA have a classic barrier to market entry operated by Article 296 and the 'Buy America' Act, respectively. As a result, government can determine whether their defence markets are competitive, oligopolistic or monopolistic, each of which will determine market conduct and market performance. For example, oligopoly markets are characterised by non-price competition (e.g. competition in R&D) and compared with competition, monopoly markets are characterised by higher prices, inefficiency and monopoly profits. Evidence on market conduct and performance is presented in Tables 9 and 10. The result of mergers and acquisitions has been a substantial increase in market concentration in EU and US defence markets. Typically, for major and costly systems, EU national defence markets are dominated by domestic monopolies (e.g. BAE in the UK; Finmeccanica in Italy). An alternative indicator of structural change is provided by concentration ratios for the top arms companies (based on SIPRI top 100 arms companies). Between 1990 and 2003, the largest firm increased its share of the top 10 arms sales from 13.5% to 17.2% and its share of the top 100 arms sales also rose from 7.8% to 10.6%; and the corresponding share figures for the three largest firms in the top 10 rose from 37.2% to 49.8% and their share of the top 100 also increased from 21.5% to 30.5% (Hartley, 2007a). Whilst these are unconventional concentration indices, they are indicative of the general trend towards larger firms and increased concentration in defence markets. Market pressures will lead to further increases in firm size and market concentration, including more international mergers and acquisitions.

39. International competition is another major market pressure. Currently, the main rivals for the EU in world defence markets are the large US defence companies (e.g. Boeing; Lockheed Martin; Northrop Grumman; Raytheon). The large US defence companies have a size advantage over their top EU rivals, reflecting opportunities to achieve economies of scale and scope (see Table 6). The US defence industry has a further competitive advantage through its considerably larger defence R&D spending. This US R&D advantage will remain so long as the EU retains its 'fragmented' national defence R&D markets. Whilst the current focus is on the US defence industry's international competitiveness, the future emergence of other international rivals such as Brazil, China, India, Japan, Korea and Russia cannot be ignored.

40. Costly defence R&D projects provide incentives for nations to collaborate to share such costs and to combine their production orders to achieve scale and learning economies in production. EU nations have extensive experience of international collaboration in defence projects. Mostly, such collaboration has been in aerospace programmes, comprising military aircraft (combat, trainer and transport aircraft), helicopters and missiles with the number of partner nations ranging from two to six (A400M airlifter). However, despite its extensive experience in collaboration, the EU nations have created few genuine European defence companies. Typically, European companies resulting from collaboration have been limited to specific projects (e.g. Panavia for Tornado; Eurofighter for Typhoon). There are exceptions such as EADS (which has major civil aircraft interests), MBDA for missiles and Finmeccanica's acquisition of AgustaWestland (with collaboration based on the Italy-UK collaboration on the EH101 helicopter). In the civil aerospace sector, the other exception is Airbus which developed from a new entrant to a world leader in large jet civil aircraft. Also, there is some limited US-European collaboration but again on specific projects only (e.g. JSF/F-35).

41. For European collaboration, there are two major questions: first, why the restriction to aerospace and second, why are there so few genuine European defence companies? Aerospace dominates because of the costs of development and the production economies available on such projects. Also, the number of nations with a large domestic aerospace industry is relatively small; and international agreements are more likely with smaller numbers of nations (the transaction costs of international collaboration are smaller where there are few parties involved). For sea and land systems, the cost pressures are not yet sufficient to provide nations with incentives to collaborate: for such systems, governments are still willing to pay the price of national independence. Also, for land and sea systems there are a large number of national defence industries throughout the EU so making it costly to negotiate international agreements involving large numbers of parties. On the second question, the answer is that there are not yet sufficient financial incentives and pressures to create such European defence companies; that national interests still dominate defence markets; and that there are restrictions on the international operation of capital markets as applied to the defence sector, including state-ownership in some EU nations.

42. Further market pressure cannot be ignored, namely, the role of competition in national defence markets and the long-run viability of specific defence industrial capabilities. Most EU national defence markets are either oligopolies or often domestic monopolies. National monopolies create problems of providing efficiency incentives and offering appropriate profit incentives and rewards for non-competitive contracts. In some situations, it might be appropriate to treat such monopolies as regulated firms

subject to a clear regulatory regime (e.g. rate of return regulation). EU nations seeking to retain a national defence industrial base (including an EDTIB) also face a further challenge, namely, that of retaining those defence capabilities which are needed for 'operational and national sovereignty' but which face major gaps in their design and production work. Often, these are industrial capabilities which are defence-specific, such as nuclear-powered submarines and aircraft carriers; or they might be some 'key' capability in the supply chain. The task for policy-makers is to identify such defence industrial capabilities; assess the alternative methods of retaining these capabilities; and their associated costs. (there are no 'free lunches').

Technological pressures

43. New technology leads to new developments in weapons systems and to the emergence of new and sometimes revolutionary weapons. Examples include new developments in defence electronics (e.g. network capabilities), the application of dual-use technologies (the application of commercial off-the-shelf technologies) and the increasing use of UAVs. Such developments will affect the future defence firm with an increased emphasis on defence electronics (see Tables 2 and 3). Pressures on defence budgets will lead to greater incentives to apply civil technology to defence projects and to focus on continuous upgrading of existing equipment so extending its operational life.

44. New technology depends on defence R&D spending. Here, the USA has a major comparative advantage and this advantage has probably increased in recent years. Evidence shows that there is a positive, non-linear relationship between defence R&D spending and equipment quality which is also reflected in a time advantage. This relationship shows diminishing returns with the USA having a clear time advantage of some 5-6 years over France and the UK: such an advantage is reflected in the international competitive position of the US defence firms (Defence Industrial Strategy, 2005, MoD, London, p39). China is expected to grow rapidly with an R&D spending level similar to the UK and France by around 2020.

Other pressures

45. Other pressures reflects all other relevant influence and drivers affecting defence markets. These include changing government attitudes to international collaboration (including greater emphasis on the efficiency of collaboration rather than work-sharing rules); the development of European initiatives on the EDTIB, the EDEM and the role of Article 296 (including the future of offsets and state aid to defence companies); and a greater willingness of the USA to open its defence market to foreign companies.

The Position of Eastern European Defence Industries

46. Since the end of the Cold War, the defence industries of Eastern Europe have experienced considerable changes (Bulgaria; Czech Republic; Hungary; Poland; Romania; Slovakia: Kogan, 2008). They have been subject to major down-sizing, restructuring and privatisation. As a result, there has emerged industries specialising in niche markets where they have established an international competitive advantage. Bulgaria has an export-oriented industry with its main products as ammunition and arms, some systems for C4ISR needs and military optics. The Czech Republic is seeking to retain ownership within the country: it retains some aviation capability but its electronics sector is not competitive. Hungary retains a competitive defence electronics industry and its aerospace capability has question marks about its future. Poland's defence industry, especially its armoured sector, remains the strongest in Eastern

Europe; its aviation sector has been privatised with foreign ownership and specialises in manufacturing components for US combat aircraft (F-16; F-18); and its electronics industry has improved substantially. Romania's defence industry, particularly its aviation sector, remains one of the leading sectors in Eastern European defence industries. Its privatised aviation industry is economically viable and profitable. Slovakia retains a defence industrial capability in military aircraft, helicopters, ammunition, artillery systems and armoured infantry vehicles (Kogan, 2008). For the future, these Eastern European defence industries are likely to become defence industry suppliers to EU, US and other defence primes.

G. Conclusion: The Future Defence Firm and Data Problems

The future defence firm

47. Defence firms have a long history of change and uncertainty. New technologies resulted in the emergence of new defence firms but all defence firms have been subject to the uncertainties of war and peace. The future defence firm in, say, 2030 or 2050 will be radically different from today's defence firm just as today's defence firms are different from those of 1950 and 1900. Boeing, BAE, EADS, Lockheed Martin and manned combat aircraft did not exist in 1900. Electronics and IT companies might be the next generation of new entrants with firms being global in their supplier networks (Hartley and Sandler, 2003).

48. New threats will create new business opportunities. For example, the threat from international terrorism will lead to new solutions to the threat (e.g. surveillance equipment for monitoring rail networks). But one 'threat' will remain, namely, constraints on defence budgets in the form of political pressures for increased social welfare spending. As a result, it cannot be assumed that today's defence firm and industry structure will survive and be relevant to the world in 2030/2050. Major changes in defence firms will impact on the future of the EDEM and the EDTIB.

Data problems

49. There is a major data gap in the form of a lack of decent economic data on defence industries and defence companies. Typically, official national statistics do not identify specific defence industries. At best, there are some industrial classifications which are clearly defence (e.g. ordnance in the UK). Otherwise, the official industrial classification identifies various defence-dependent industries, namely, aerospace and shipbuilding; but these report aggregate data which comprises both civil and military sales.

50. Similar problems arise with company data where military and civil sales are aggregated; and military sales comprise both sales to national government and export sales. Moreover, the published company data often focus on the top 100 firms (e.g. Flight; SIPRI) to the neglect of supply chains and supplying firms many of which are SMEs. **There are major gaps in our knowledge of defence industry supply chains for air, land and sea systems within the EU Defence Industries.** We lack data on which firms are involved as suppliers in supply chains; their location; the importance of defence in their total business; the importance of the firm in its local labour market; the importance of the firm in the supply chain (e.g. is it a key supplier and the only one in its national market; are their rivals elsewhere in the EU or is it an European

monopoly?). Many of these firms are SMEs and little is known about their financial viability and hence their long-run presence in the EDTIB. In contrast, we know more about the large suppliers in the EDTIB. Examples include firms such as SNECMA(Safran) and Rolls-Royce as aero-engine suppliers; Smiths Aerospace (acquired by GE in 2007) as an avionics supplier and Cobham involved in supplying air refuelling, avionics and defence electronics.

51. For almost all defence companies, the lack of financial data on their defence business means that it is difficult for outsiders to assess the financial viability of the defence component of their total business. Nonetheless, for privately-owned defence companies, the standard signalling mechanism of a company's financial fortunes is reflected in its capital market performance. Here, the standard performance indicators are profitability and the associated share prices. Relatively poor profitability compared with other firms and industries is reflected in falling share prices, management and board changes, sales of unprofitable parts of the business, mergers and take-overs and ultimately, bankruptcy. These are important signals about the financial viability of the EDTIB. Overall, the best single source of *published* data on defence companies is the SIPRI Top 100 arms producing companies.

52. Thus, **efforts by the EC and EDA to assess the EDTIB and the EDEM encounters major data problems. The available published data are useful but no substitute for actual data on company defence sales, productivity and profitability. However, data collection by the EC and EDA imposes costs on the defence industry. The position is further complicated because most national defence ministries are confronted with precisely the same data problems in relation to their national defence industries.** However, national defence ministries usually have access to contract data for firms. Also, for non-competitive contracts some ministries have access to the detailed costing data and firm performance for specific projects (which allows procurement staff to assess a firm's performance and efficiency). Often, though, these data are commercial-in-confidence and cannot be released to the EC and EDA (see Hartley and Lazaric, 2008)

B Annex: Country case studies

B.1 Case study: Defence related industry in Bulgaria, 2008-2018[3]

Evolving national context

Summary of recent history
As a member of the Warsaw Pact, Bulgaria was a major producer of defence items, primarily of small arms, light weapons, ammunition and communications equipment, with annual exports exceeding USD 1 billion in the peak years at the end of the 1980s. Although defence companies generated close to 10 percent of Bulgaria's GDP, only about 5 percent of their production went to domestic sources, mainly to the Ministry of Defence. They were 100 percent state owned, and tightly coupled with the Soviet military industrial complex to the extent that very few defence products could have been produced by national sources alone.

After the end of the Cold War, the defence industry went through massive reductions in production and sales, and the consequent downsizing. During the process of privatization in the 1990s and the beginning of this decade many of the companies were sold to existing management, while the government preserved its shares in some. Currently 90 percent of the defence companies are privately owned, but unlike Poland,[4] The Czech Republic,[5] and Romania,[6] for example, Bulgaria was not able to attract strategic owners or investors.

With the start of a new procedure for privatization of TEREM EAD—defence repair company with eight factories and some 3,500 employees—the expectation is that the process of privatization of the defence companies will be practically finalised. At this stage the state intends to preserve up to 34 percent ownership in several key companies.

Economic environment
From the 1990 till 1997 Bulgaria's economy went through a dramatic decline. Since then it stabilized and started to grow, but the GDP per capita regained the 1989 level only in 2003-2004. The growth of the GDP for the last five years is over 6 percent per year, and most economists predict sustainability of a growth at about this rate.

The country is financially stable. And while the inflation rate in 2007 reached 12.5 percent (arguably, due to opening markets and raising consumer prices after EU accession) and there is no near-term prospect for joining the Euro zone, credit and investment risks are assessed as low. The banking system (other than the Central Bank)

[3] This case study was prepared by Todor Tagarev on an assignment by TNO within the framework of the Study. Dr. Tagarev is Chair of the Defence and Force Management Department of the Defence and Staff College in Sofia and Director Research and Publication Programmes of Procon Ltd.

[4] Polish defence companies attracted as owners companies like EADS and the U.S.-based Pratt and Whitney and Sikorsky Aircraft Corporation.

[5] Lockheed Martin bought shares in Aero Vodochody – the Czech prime in the aviation sector.

[6] The Romanian aviation and electronic sector attracted the interest of Lockheed Martin, Eurocopter, and Israeli companies.

is in private hands, and the majority of banks are subsidiaries of major banks from EU countries.

The unemployment rate fell down from over 20 percent at the peak around the year 2000 to under 7 percent of the labour force, and a portion of the unemployed is likely involved in shadow economic activities. Combined with growing investment, including foreign direct investments in the industry, and negative demographic trends, this leads to an emerging lack of qualified labour.

Thus, while throughout the 1990s and the first half of this decade major objective of the trade unions in the defence industry was to preserve jobs, a major problem in near- and mid-term will be the availability of engineering expertise and skilled labour at a competitive cost.

Evolving defence policy

Defence ambitions and force development
The defence establishment in Bulgaria still struggles to find the balance between NATO (and to a lesser extent - EU) commitments, technological ambitions and, as a very recent phenomenon, the necessity to preserve the attractiveness of the military profession, exacerbated by resistance to the inevitable scrapping of excess command levels and their supporting units, infrastructure and weapon systems.

Thus, in November 2004 (after the NATO Istanbul summit decisions on increasing deployability of forces, as well as the percentage of forces in operations) the Council of Ministers approved the long-term defence plan known as Plan 2015. This plan envisioned slight downsizing of personnel by 2015 to approximately 39 thousand service personnel and 10 thousand civilians. In parallel, the Government approved a relatively ambitious program for technological modernization of the armed forces.

Independent analysis showed that this plan was not sustainable and does not provide for meeting the deployability commitments made in Istanbul. Hence, it was not surprising that most of the procurement tenders did not progress as announced in the Governmental decision.

Logically, and catalyzed by the full professionalization of the armed forces at the end of 2007 with the ensuing recruitment problems, on 21 March 2008 the Council of Ministers approved a new, 'Updated Plan 2015'. It envisions further reduction of military personnel to 32 thousand service men and women and lower numbers of major weapon systems – all that in a substantially different budget framework. For the first time it also states defence ambitions in terms of contribution to out-of-area operations – sustainable contribution with a battalion tactical group and a company [7] plus just over a token contribution from the Air Force and the Navy.

The version open for public use does not provide details on the transition, but includes information of the numbers of major platforms that need to be operationally ready:

- In the Land Forces: 160 tanks, 378 armoured vehicles, 192 artillery systems of calibre over 100 mm (excluding mine throwers);

[7] No evidence has been provided, however, that such a contribution would be sustainable.

- In the Air Force: 20 [multipurpose] combat aircraft, 10 transport airplanes (only five C-27J Spartan are currently procured), 18 trainer aircraft (six ••-9• Pilatus have been procured so far), 12 attack helicopters (a higher number of Mi-24s is in service, but the contract for their upgrade was terminated), and 18 transport [utility] helicopters (a contract for the delivery of twelve helicopters AS 532AL "Cougar" was signed in 2004; a part has been already delivered);
- In the Navy: six combat ships [frigates or corvettes], 14 combat support ships [e.g. mine warfare ships], six auxiliary ships, and six helicopters (six AS 565 MB "Panther" helicopters will be delivered by Eurocopter in the same contract covering the delivery of the Cougars).

Defence budget

Predicting Bulgaria's defence budget is a notoriously risky matter. For example, Plan 2015, approved at the end of 2004, was based on the assumption that from 2005 till 2015 2.55 percent of the GDP will be spent on defence, and the investment portion of the defence budget will steadily grow from 15 percent in 2005, to 21 percent in 2008, to 27 percent in 2015.

In November 2007 with its decision # 713 to start the process of updating Plan 2015, the Government committed to earlier decisions to spend 2.6 percent of the GDP on defence. Curiously, a few days earlier it had approved the three-year framework for the state budget planning that allocated to defence 2.18 of the GDP in 2008, 1.98 in 2009, and 1.89 in 2010. The latter is the framework used in the process of updating Plan 2015.[8] Announcement have been made in the sense that in the following years the defence budget will go further down to no more than 1.8 of the GDP.

The publically available Plan does not provide information on the investment portion of the defence budget, but points out as priority the modernization of those forces earmarked for participation in out-of-area operations.

From 1999 till 2002 the Ministry of Defence maintained a trend of increasing its R&D budget. Since then, however, it went down to under 0.3 percent of the defence budget. Even this miniscule budget is not always spent on research, and no clear priorities can be identified in the MOD R&D program (possibly, the single exception being the advanced material research at the Institute of Metal Science of the Bulgarian Academy of Sciences).

Procurement regulations

The MOD contracting process is practically exempt from the regulations of the Law on Public Tenders. Instead, it is regulated by a Governmental Ordnance that empowers to a great extent the Minister of Defence and—in regard to offsets—the Minister of Economy. For example, as a rule the participation in tenders is by invitation only, and very often the MOD announces technical specifications without clear link to operational requirements (and thus, often favouring a particular product or company).

Bulgaria has practically no experience in coordinating the procurement of defence items and services with other countries, and as yet no defence official has made statements that a replacement of the purely national approach is being contemplated.

[8] According to the official forecast, in 2008 Bulgaria's GDP will be just over 31.5 billion Euro.

Forthcoming defence procurements

The following forthcoming major defence procurement projects would potentially have highest impact on the development of defence-related industry in Bulgaria:

- Multipurpose fighters. The updated Plan 2015 calls for 20 platforms, but more probably a smaller number will be procured (e.g., 12 combat and four combat/training aircraft). According to the MOD, a contract has to be signed by the beginning of 2010 at the latest.
- Upgrade of the Mi-24 attack helicopter. A new tender procedure will be launched in 2008.
- Naval combatants. In 2006 during a tender procedure the MOD listed Corvettes Armaris on the top of the list of participating suppliers. The French company proposed four Gowind Corvettes and a large program for direct offset. However, no contract has been signed yet due to budgetary constraints. In the meantime, in December 2007 the Council of Ministers approved the MOD proposal to procure two second-hand frigates from Belgium (one was already bought in 2005). It is safe to predict that only one of these two projects will be realized in mid0term, and possibly till 2018.
- C4ISR systems. The major C4ISR systems in the MOD modernization plans are:
  - √ Coastal surveillance system;
  - √ CBRN surveillance and reconnaissance system (with stationary and mobile components);
  - √ Field communications for the Land forces;
  - √ Enhancement of stationary communications.

In addition to the ongoing projects and pending procurements, described above, impact on defence-related industries is expected from:

- The modernization of several types of vehicles, primarily for the logistics of the Land Forces, under a contract with DaimlerChrysler (currently Daimler AG).
- Procurement of seven armoured vehicles M1117 from the US company Textron Marine & Land. According to the company website, it has a framework contract which allows the Ministry of Defence to purchase additional ASVs in the M1117 base configuration or variants with modifications. The MOD has not announced intentions to procure additional armoured vehicles of this or other types, but with the ambition of maintaining a battalion tactical group in operations, it would surprising if it does not.
- Procurement of individual and specialized equipment and protective means for deployable units from the Land Forces and the Special Operations Forces.
- Bulgaria's participation in the TIPS consortium, developing the NATO's Air Ground Surveillance system.
- Bulgaria's part in the group of 1 NATO nations negotiating the procurement of three or four Boeing C-17 Globemaster III long-range cargo jets.

No public information is available on numbers and modernization plans for air surveillance radars and the ground based air defence. Since Bulgaria still relies on upgrades of legacy Soviet radars[9] and missile complexes, it is relatively safe to predict that in mid-term, and certainly till 2018, Bulgaria will procure two or three long-range radars, will upgrade its IFF system and, possibly, will procure a number of ground-based missile complexes.

[9] Unlike Romania, which at the end of the 1990s upgraded its air surveillance system with Lockheed Martin TPS-117 radars, and currently the Romanian company UTI Systems S.A. co-produces and assembles the TPS-79 Multi-Mission Surveillance Radar systems (so far for national needs only).

Defence industrial policy

State Policy
Since decades Bulgaria does not have a defence industrial base *per se*. During the Warsaw Pact time, as well as today Bulgaria's defence companies are export oriented, while the defence establishment relies on foreign sources for the procurement of platforms, as well as advanced communications and information systems. Hence, as long as a national defence industrial policy exists, it relates to:
The ability of the country to provide the maintenance and—in dire times—repair of weapon systems and military equipment and reliable supply of small arms, light weapons, ammunition, and individual equipment; and
Economic development and social issues.

To achieve the first of these objectives the state preserves shares in some of the defence companies so that they would not change their profile to the detriment of the sustainability of a war effort.

Offset policy
The current Government, formed in 2005, raised the expectations related to offset arrangements as part of major defence procurements. In his address to an international conference on offsets, Bulgaria's Prime Minister Sergey Stanishev stated that: "The goal of the offset arrangements is to lead to higher economic growth and increase of the Gross Domestic Product of the country, as well as to technology transfer and creation of new jobs." [10]

Curiously, the Government sees offsets also "as a tool for investment in modernizing the armed forces."[11]

The previous Government had already adopted offset regulations; however the MOD could decide on including or not offset obligations in a procurement contract. In the very beginning of 2007 the current Government issued an "Instruction for Granting Special Public Contracts" [12] that made offset arrangements mandatory for defence procurements over certain threshold.[13]

The Instruction delineates direct and indirect offsets, assigns responsibility for each type respectively to the Minister of Defence and the Minister of Economy and Energy, and fixes the proportion between the two types at 30:70 percent.

The Minister of Economy and Energy further defines the areas where indirect offset should be channelled. But although high-tech offsets have certain advantage (e.g., use of higher multipliers), currently defined areas are so broad that defence-related industries do not enjoy any particular advantages in comparison to other industrial and service sectors.

[10] "Stanishev: The offset arrangements will allow us to seek investments in other economic sectors as well," Dnes +, 28 November 2007, available in Bulgarian at www.dnesplus.bg/Business.aspx?f= 102&d=194977.
[11] Ibid.
[12] "Instruction for Granting Special Public Contracts," State Gazette, no. 7 (23 January 2007).
[13] Approximately € 5 million, excluding VAT.

This is exacerbated by the probably unique definition of direct offset. According to the Instruction, direct offset obligations are those obligations "related to the object of the contract for special public orders." Although that does not preclude involvement of or investments in Bulgaria's defence companies, the Ministry of Defence too often uses this clause to procure from the prime additional items and services, necessary to achieve the intended level of capability, e.g. infrastructure development, training of military personnel, procurement of spare parts and the like.

As a result, the only typical direct offset arrangement so far is with the U.S.-based Harris Corporation that transferred know-how and assembly of tactical radios to "Electron Progress" in a USD 15 million offset arrangement, related to the procurement of a Field Integrated Communications and Information System (FICIS) at the end of the 1990s. Another example might be the involvement of a local company by DaimlerChrysler in the maintenance of military vehicles.

No offsets have been directed to RD organizations, although few proposal from Bulgarian organizations have been approved by the Ministry of Economy and Energy and included in the list of potential offset deals.[14]

Policy of defence industrial companies

The Bulgarian Defence Industrial Association (BDIA), created in 2004, has almost all major defence-related companies as members.[15] BDIA representatives often express their frustration that none of its members has played a part in the modernization of the Bulgarian armed forces. As a result, notwithstanding its high profile and declared objectives,[16] it calls for protectionist measures by the government so that:

1. BDIA members are contracted by the MOD as primes, and
2. MOD limits the use of small Bulgarian companies (that according to BDIA have no adequate track record) and contracts instead the major producers of military equipment (that are also BDIA members).

Defence R&D

Bulgaria's defence R&D were among the first to suffer from the downsizing after the end of the Cold war. Currently, the MOD maintains only one research institute with approximately 40 researchers. Several institutes at the Bulgarian Academy of Sciences [17] still conduct defence-oriented research and maintain technological capacity, and while there are cases of their cooperation with EU research organizations and industries, this more an exception rather than a rule.

For example, although Bulgaria had good traditions in space research, it is not yet a member of ESA. Against this background research institutes, traditionally specializing in the development of on-board devices/sensors for civilian purposes and decision-support systems, attempt to maintain their close relations with counterparts from the Russian Federation.

Traditionally, Bulgarian universities focus on teaching, but there are example s of university research and technological development of potential dual use.

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[14] A menu, from which an offsetor can choose.

[15] Electron Progress is a major exception.

[16] For the BDIA objectives refer to www.bdia-bg.com/english/statute.html.

[17] The academy is autonomous to an extent, but to a great extent still relies on financing through the state budget.

The R&D efforts of defence companies have a near to mid-term focus and are subject to budget limitations.

Possible shifts by 2018

Defence ambitions, force development, and budgets
The assessment of this author is that even the updated Plan 2015 does not balance defence ambitions and resource constraints, and after a few years there will be a new decision for downsizing, with military personnel going down to about 20 thousand or even less. In a moderately optimistic stance, the new downsizing would affect primarily redundant command levels and in-place forces with the related infrastructure, thus providing for investment in new capabilities and sustainable participation in operations.[18] The realization of one or another of the scenarios would have a very limited impact on these developments in mid-term, but may have an impact on defence posture in long-term.

In near-term, the defence budget as a percentage of GDP will be reduced to 1.8 percent as planned. In longer term defence budget levels do depend on the emerging scenario in a way similar to that for other EU countries.

The same applies to the defence investment budget.

Defence investment
Under declining budgets and growing requirements for contribution to allied and coalition operations, no major procurement other than the projects listed above is expected in near- and mid- term. In longer term, the type of platforms and equipment procured does depend on the scenario under realization.

The ability of Bulgaria's government and society to increase transparency and moderate corruption risks will have a major impact on outsourcing defence services and implementing public-private partnerships in defence. This is a mid-term task that has to be solved in order to prevent inefficiencies, waste, corruption and outright collapse of public confidence in the defence establishment, no matter whether Bulgarian or foreign companies are involved.

National-only procurement of defence products and services will continue to dominate in near and mid-term. If the AGS and the C-17 projects turn out to be a success, and are perceived as efficient and successful by decision makers in Bulgaria, in long-term the country will rely more on joint procurement, be it multinational or on a bi-lateral basis with other EU member countries.

The current offset arrangements will be maintained in the near future. In mid-tem it will be wise to focus offsets in order to enhance the innovative and competitive potential of Bulgarian defence companies and R&D organizations and/or their integration in the supply chain of major European or U.S. companies.[19] In long-term, given (1) a substantial progress in the development of European-wide defence technological and industrial base that integrates a reasonable portion of the defence-related companies,

[18] The ambition to sustain a battalion tactical group and a company in operations, plus air force and naval capabilities will have to be moderated to an extent.
[19] But there are no guarantees that this will be the case.

based in Bulgaria,[20] and (2) inclusion of Bulgaria in multinational defence procurement initiatives, programmes, and projects,[21] offset regulations will become redundant.

Defence research, technology, industrial policy
So far, Bulgarian defence research organizations have a token participation in EU defence-related research.[22] Somewhat higher is the level of participation in the NATO forums. Participation is expected to increase. Developments in mid-term depend primarily on the evolution of Bulgaria's defence R&D policy, but also—and to a critical degree—on the lack of the respective management capacity. In longer term defence-related R&D can be competitive in certain niches only if investments are provided, possibly as part of earlier offset arrangements or increase and focusing of governmental funding.

Current efforts of defence companies and their association to seek protection run counter to potential integration in the EDTIB. This is likely to persist in near term. Nevertheless, and for various reasons, this author does not expect introduction of protectionist measures by the Bulgarian Government in any of the scenarios. Hopefully, rather that calling for governmental policies that go completely against free market principles, BDIA will focus on achieving the objectives in its Charter.

The MOD will still seek a level of independent (or rather – in-place) capacity to maintain weapon systems and equipment. Our expectation is that this policy will be preserved, at lest in near to mid-term until a combination of economic restructuring, raising confidence in the reliability of foreign defence suppliers, e.g., from other EU countries, and advantages in cost-benefit terms may make the MOD willing to rely on support and services, provided by foreign companies. Whether these will be companies from EU member states, from North America or elsewhere, depends on the scenario under realization.

Differentiation by sub-sectors
The table below outlines possible developments of defence-related companies by sectors and sub-sectors in long-term (by 2018), showing the relation to certain scenarios if it is considered important.

Platforms	Comments
Sea platforms	The cooperation and integration of Bulgarian companies will depend on the procurement of frigates and/or corvettes, both likely from EU sources
Land platforms	For armoured vehicles – U.S. company. That may change to cooperation with EU companies, in particular under scenario "S" Daimler AG is seen as a long-term partner for various trucks and other vehicles wheeled vehicles
Air platforms	Combat aircraft – cooperation will depend on the selection of a prime contractor in a forthcoming procurement. Both U.S. and EU companies are expected to compete Tactical transport aircraft – possible cooperation with Alenia (Italy) or the US companies in the C-27 group Strategic airlift – possible cooperation with Boeing or some of its subcontractors; cooperation with Russia and/or Ukraine is also a possibility in scenarios "W" and "E" Helicopters – possible cooperation with Eurocopter; near-term cooperation with Russia related to the upgrade of Mi-24 cannot be excluded

[20] Depending, to a degree on the scenario under realization.
[21] Which to a large extent is a matter of Bulgaria's choice.
[22] Keeping in mind that Bulgaria is EU member only since January 2007.

Platforms	Comments
GBAD	No information on the MOD plans is publically available. The cooperation will depend primarily on the selection of a contractor in the future. Both US and EU contractors will be invited in all scenarios. Cooperation with Russia cannot be excluded in scenario "E"
Weapon systems	
Artillery	No major interests
Small arms and light weapons	Bulgaria will continue to rely on national sources
C4ISTAR	
C2	Current cooperation is primarily with U.S. companies, but EU companies also play a role. The likelihood to cooperate with EU companies increases in scenario "S", as well as in other scenarios if EU companies successfully compete for the coastal surveillance system and the naval sovereignty operation centre
Communications	Current cooperation is primarily with U.S. companies, and this is the likely long-term trend
Radars	A Bulgarian company does subcontracting work for an EU prime. Further developments will depend on the selection of a contractor for the upgrade of the air surveillance system. Both US and EU companies are expected to compete. Involvement of Russian companies cannot be excluded in scenario "E"
Optics	Bulgarian companies successfully cooperate with both U.S. and EU companies
Specialized sensors	Cooperation with US companies for mobile CBRN reconnaissance is likely
Decision support systems	Bulgaria has a capacity to be a sub-contractor for the development of analysis tools and decision support systems
Software development	Bulgarian companies are often used by both EU and U.S. companies outsourcing software development
Logistics	
Strategic lift	See "Air platforms" above
Maintenance & repair	Traditionally, this is a strong sector in Bulgaria. Any successful prime would be expected to cooperate with a local company to provide maintenance and repair, as well as to include it in its supply chain
Medical services	There are possibilities for cooperation, in particular if Bulgaria decides to provide niche capabilities in medical support to expeditionary operations [23]
Individual equipment	Bulgarian companies have capacity, in particular in the production of individual protective equipment, that may of interest for EDTB developments
Training and simulation systems and services	No specific expertise exists, but the capacity of Bulgarian companies and research organizations may be utilized in software development and operations research

B.2 Case study: Finland

Documents (and other sources)
"Finnish Security and Defence Policy", White Paper dates from 2004.
Summary at
http://www.defmin.fi/files/310/2574_2160_English_Summary_2004_1_.pdf
Full paper also available.
www.defmin.fi

General
The vision of the Strategy is *"The Finnish defence and security industry is specialized, competitive and networked in the international market. It contributes to security, national and international military capabilities as well as security of supply."*
In order to achieve the Vision and the goals of the Strategy, the capacities and operational preconditions of the domestic industry must be improved. Moreover, the Strategy outlines several near-term measures to achieve these goals. Through cooperation, the public sector and industry jointly implement the Strategy.

[23] But while reasonable, such decision has not been made so far.

The Defence Forces and industry must commit to shared long-term planning in order to improve industrial capacities. Instead of concentrating on production figures, they must strive for competence-based industrial expertise.

Remarks on EU cooperation and EC initiatives
The preliminary Finnish position as to the Commission proposal (i.e. Greenbook on Defence Procurement) is tentatively positive. According to the Finnish view, this project supports significantly the development of the Common Foreign and Security Policy. Finland supports gradual steps to mutual opening-up of the defence equipment market in order to strengthen the European market. In the longer run, Finland is in favour of the establishment of the European defence equipment market. However, the special national needs, such as security of supply, have to be taken in account in this process.

The EU's new European Defence Agency currently being set up plans to improve operating conditions of industries on the European defence materiel market, and the Finnish defence industry must monitor and participate in these processes to the best of its ability.

The availability of sufficient and up-to-date military equipment is an essential part of Finland's defence capability. International defence materiel cooperation is one of the means to achieve this end as well as guarantee military security of supply.

Finland participates in international defence materiel cooperation in a variety of ways, both bilaterally and multilaterally. Bilateral cooperation is primarily based on a network of Memoranda of Understanding (MOU) between the Finnish Ministry of Defence and their foreign counterparts. Bilateral cooperation extends to the fields of research, development, production, maintenance, quality assurance and procurement. One of the main objectives is to create preconditions for military security of supply under emergency situations.

Remarks on Demand side
The Army's readiness brigades will be fully operational in 2008, and their firepower and mobility will be expanded. The Army's striking power will be improved. From 2009, the emphasis in the development of the Army will be on ground-based air defence and regional troops. The focus in developing the Navy will be on protecting sea lines of communications, improving mine counter-measure capability and on developing mobile coastal troops. In the Air Force, particular emphasis will be placed on developing the capability of fighter defence and the air defence command and control system. The capability of the Hornet fleet will be improved by mid-life updates, in addition to which purchases for a long-distance precision guided weapon system enabling air-to-surface operations will be started.

Remarks on Supply side
As regards military security of supply, the domestic defence industry is of vital importance to the Defence Forces. It is essential to guarantee domestic integration and maintenance capacities as well as crisis repair expertise. However, the Defence Forces alone cannot sustain the domestic defence industry. Therefore, specific action and, consequently, a national industrial strategy are required.

The Finnish defence materiel industry must manage three areas of competence that are essential from the point of view of defence

- The assemblage, maintenance and repairing of large, technologically demanding systems
- The management of information systems technology and systems integration
- Availability (and if necessary, manufacture) of critical components and spare parts.

In any case competence in gunpowder and ammunition production and in various production methods will continue to be needed in Finland in the future. This competence could be maintained in, for instance, centres of excellence jointly run by the industry, research institutions and defence administration.

Safeguarding the operating conditions of industry also means ensuring realistic export potential for its products. Industry must strive to develop networks not only in Finland but also with European structures and project programmes, and, according to the possibilities, efforts will be made to give public support to its export endeavours. It must be able to participate in European joint projects, especially in aeronautics, and to enhance its know-how by seeking contracts on defence materiel component manufacture and assembly work here in Finland.

Remarks on Market place
… and develop a well-functioning, viable and expert defence materiel industry. This applies to the manufacture of materiel produced competitively either for the Defence Forces or for Finnish industry in general. Domestic industry takes part in international defence materiel cooperation either as part of the Defence Forces procurements or independently.
The Finnish defence materiel industry plays an important role in maintaining and developing the country's defensive readiness. The aim is to involve the industry in defence administration procurement processes and technology projects at an early stage of planning so that the industry's views can be taken into account.

The Finnish defence materiel industry plays an important part in the upholding and development of the Defence Forces.

When the Finnish Defence Forces make large purchases of defence material from foreign suppliers industrial participation (formerly offset deals) is required. Supply contracts are subject to the condition of offset usually when the value of the procurement exceeds € 10 million. Industrial participation is designed to safeguard domestic security of supply. The aim is to involve the industry in materiel and technology projects already at the planning stage.
The paper stresses cooperation with EU but also NATO via PfP. Threat includes terrorism with WMD, cyber but also crime.

B.3 Case study: France

Documents (and other sources)
Livre Blanc de Defense et Securité National, Juin 2008
(The French White Paper on defence and national security, June 2008)
www.defense.gouv.fr

In this country paper we first look at the French strategy in general. In the second part we will attempt to relate that strategy to the EDTIB strategy (EDA, 2007).

Summary of policy

General

The recent French White Paper on defence and security replaces the previous document from 1994. It fully takes into account the developments in the global security situation of the last decade and it is no surprise that it is not restricted to defence but that it covers defence and (national) security. The strategy looks ahead over a period of 15 years. Its importance is implied in the statement that "this White Paper will serve as the foundation for downstream multi-year planning and spending decisions".

> "The national security strategy includes five strategic functions which the defence and security forces must master: knowledge and anticipation, prevention, deterrence, protection and intervention. The combination of these five functions must be flexible and evolve over time, adapting to the changes in the strategic environment. The White Paper will therefore be updated before the discussion of each new Military Programme and Interior Security Bills."

The Paper proposes changes for the individual forces, in particular a reduction in personnel. But this will not lead to decreasing budgets, on the contrary:

> France shall devote a major financial effort to its defence, consistent with the priorities and choices made for its operational capabilities. Therefore de-fence spending will not decrease. During the initial period annual resources (excluding pension charges,) will be constant in volume, that is, increasing at the same pace as inflation. They could include exceptional resources. Then, during a second phase, starting in the year 2012, the budget will increase at the pace of 1% per year in volume, that is, 1% above the inflation rate. Between now and 2020, the aggregate effort devoted to defence excluding pensions will amount to 377 billion Euros. In parallel, restructuring will lead to considerable decrease in staff over six or seven years and operating cost reductions in the Ministry and the armed forces. The resulting savings will be totally reinvested in the procurement budget which will increase from an average of 15.5 billion Euros in past years to 18 billion Euros on average per year for the period 2009-2020, and also in the improvement of defence personnel training and living conditions.

Remarks on EU cooperation and EC initiatives

The French defence strategy clearly promotes European collaboration and the strengthening of European defence capabilities.

The French White Paper on defence and national security states:

> "The White Paper advocates the drafting of a European White Paper on Defence and Security.
> Since its beginning, European Security and Defence Policy (ESDP) has been built outside the Treaty provisions: ESDP is the result of inter-governmental cooperation within the EU council.

> The French white paper states that European defence policy is a necessity: the EU has no other choice than shouldering more strategic responsibilities."

And:

> "The European ambition stands as a priority. Making the European Union a major player in crisis management and international security is one of the central tenets of our security policy. France wants Europe to be equipped with the corresponding military and civilian capability. The White Paper proposes several concrete goals for European defence in the coming years :
> - Set up an overall intervention capability of 60,000 soldiers, deployable for one year in a distant theatre with the necessary air and naval forces;
> - Achieve the capability to deploy for a significant duration two or three peace-keeping or peace-enforcement operations and several civilian operations of lesser scope in separate theatres;
> - Increase the European planning and operational capability both military and civilian, in parallel to the development of interventions outside the European Union;
> - Create impetus and restructure the European defence industry."

The French Délégation Générale pour l'Armament (DGA) speaks also clearly on the various fora for arms collaboration in Europe:

> "La construction de l'Europe de la défense est un objectif essentiel de la politique de défense. La DGA favorise ainsi une politique européenne d'armement, tout en s'assurant du respect des engagements à l'égard de l'alliance Atlantique. La coopération permet aux États européens de partager les coûts de développement des matériels militaires et de bénéficier d'économies d'échelle. Elle assure également l'interopérabilité entre les forces armées européennes. La DGA entretient une coopération bilatérale très active avec ses principaux partenaires européens. Mais ce qui caractérise la période récente, c'est l'émergence de cadres multinationaux de coopération : création de l'Organisation de coopération conjointe pour l'armement (OCCAR) en 1998, mise en place de l'accord-cadre LoI (*Letter of Intent*) entre les 6 principaux pays producteurs d'armement européens en 2000 et, en 2004, création de l'Agence européenne de défense, fer de lance du développement de la coopération européenne dans le domaine de l'armement."

European collaboration in R&T has increased the last three years, representing 13% of the total french R&T fundings in 2005 and 20% in 2008.

Remarks on Demand side

The White Paper is reasonably specific on the future needs and priorities. This is very well illustrated by the following 10 points (out of a list of "Fifteen Prescriptions"):

1. **Force protection and land combat capabilities** will benefit from the acquisition of new pieces of equipment, such as 650 new generation infantry fighting vehicles (VBCI); 25,000 individual kits for infantry combatants (*Felin*); hundreds of armoured cargo vehicles protecting against bombs, landmines and IEDs; a new long-range rocket taking into account the prohibition of cluster-bomb ammunition; increased responsiveness in the acquisition process via crash programs.

2. **Drones for surveillance and combat drones** are in great demand for air-land operations. Fighter aircraft and unmanned aerial vehicles increasingly complement each other.
3. **Nuclear attack submarines (SSNs) carrying conventional cruise missiles** are a priority. Due to their stealth and virtually unlimited range, they represent versa-tile strategic systems that can be used for intelligence, protection of the SSBNs, escort of the aircraft-carrier or special operations. The White Paper sets a target of six SSNs. Cruise missiles will thereafter be carried by aircraft as well as by naval assets, based on a development emphasising a high commonality between both versions.
4. **Large amphibious ships** (*Mistral* class) have significant amphibious, airmobile and command capabilities. Together with 18 first-line frigates, they will constitute the backbone of the *Marine nationale* missions of presence and intervention. Four amphibious ships of that class should be available by 2020.
5. **Detection and early warning capabilities** represent one of the major innovations to be found in the White Paper. They are aimed at ballistic missile capabilities that could be targeted on France or Europe and include very long-range radars and geostationary satellites. France expects this programme to acquire a European dimension as soon as possible.
6. The air strike component (combat aircraft) will be reorganised as a **single pool of 300 combat aircraft** (*Rafale* and modernised *Mirage* 2000) from both services (Navy and Air Force), with management handed over to the Air Force. This new organisation should significantly increase synergies and the fighting potential of our air assets.
7. The priority given to **satellites** is manifest by **doubling funding available** for military programs (from a base of EUR 380 million in 2008) and by establishing a **Joint Space Command**, under the authority of the Chief of the Joint Staff. The **Air Force** will be tasked with the implementation and control of military space as-sets.
8. **Cyber-war** is a major concern for which the White Paper develops a two-prong strategy: first, a new concept of cyber-defence, organised in depth and coordinated by a new **Security of Information Systems Agency** under the purview of the General Secretariat for Defence and National Security (SGDSN); second, the establishment of an **offensive cyber-war capability,** part of which will come under the Joint Staff and the other part will be developed within specialised services.
9. Intelligence collection depends heavily on high-definition day and night **imagery**, to be deployed as a successor program to the *Helios* satellite series (the MUSIS program). **Signal interception** is just as important and depends on a variety of assets based on land, at sea and in the air. A space-based capability will be added (the CERES program).
10. The White Paper stresses **the importance of civilian and civil-military crisis management operations.** It advocates the development of new capabilities within the ministry of Foreign and European Affairs, by establishing an **Operational Centre for External Crisis Management** which will be responsible for advance planning, execution and termination of international crisis management activities. Specific statutes will facilitate mobilisation of civilian experts belonging to the Civil Service. Inter-ministerial funding of these activities will also be improved.

Of course, these priorities have to be detailed in specific plans in the coming years and depend on the availability of budgets. The table below gives an indication of the developments over the past 20 years (also an indication of the behaviour of the French government with regard to defence spending).

Military Expenditure of France		
Year	constant (2005) US$ m.	% of GDP
1988	56.897	3,6
1989	57.594	3,5
1990	57.340	3,4
1991	57.713	3,4
1992	55.897	3,3
1993	55.278	3,3
1994	55.562	3,3
1995	52.812	3
1996	51.543	2,9
1997	51.731	2,9
1998	50.345	2,7
1999	50.787	2,7
2000	50.205	2,5
2001	50.036	2,5
2002	51.064	2,5
2003	52.615	2,6
2004	54.059	2,6
2005	52.917	2,5
2006	53.199	2,4
2007	53.579	*

Remarks on Supply side

The White Paper (Chapter 16 Industry & Research) clearly states that France wants to maintain national industrial capabilities in certain critical areas but otherwise will support the creation of a strong European Defence Industrial Base. The following statements on this issue have been made:

> "Les compétences scientifiques, technologiques et industrielles de la France conditionnent sa capacité à satisfaire les besoins des armées, ceux de nos partenaires européens, et de plus en plus ceux des forces de sécurité intérieure et de sécurité civile. Elles doivent permettre à la France de conserver son autonomie stratégique et contribuent à promouvoir l'Europe comme un pôle d'excellence industriel et technologique ".

> "Defence industry must be European in order for its companies to become competitive worldwide. Individual European countries can no longer master every technology and capability at national level. France must retain its areas of sovereignty, concentrated on the capability necessary for the maintenance of the strategic and political autonomy of the nation: nuclear deterrence; ballistic missiles; SSNs; and cyber-security are amongst the priorities. As regards the other technologies and capacities that it may wish to acquire, France believes that the European framework must be privileged: combat aircraft, drones, cruise missiles,

satellites, electronic components etc., although procurement policy must include acquisitions on the world market."

"The White Paper notes that the mastery of all the technological capabilities at national level is no longer possible. France must, however, maintain the national capability required to ensure its strategic and political autonomy in a limited number of critical sectors, such as: nuclear deterrence, ballistic missiles, nuclear submarines (SSBNs and SSNs) and information system security.
France believes that as regards other technologies and capabilities that might be required, the European framework should be privileged. This is the case for fighter aircraft, cruise missiles, satellites, electronic components, etc. The procurement policy must also be open to purchases on the world market. Stimulating industrial cooperation in Europe means in particular:

- Pursuing joint analysis of military requirements;
- Reinforcement of the action of the European Defence Agency;
- Defining joint rules for defence procurement."

In a following paragraph on "Industrial and technological priorities for 2025", this is further detailed with remarks on the various sectors within the defence domain. As illustrated with three examples (quotes) below:

- "France will retain a national design and production capability for nuclear-powered submarines. All other components of sea power, such as conventional submarines or surface ships, are open to European cooperation."
- "France will support the inception of a European military aircraft manufacturer capable of designing future combat systems, manned or unmanned. France will contribute actively to the implementation of a strategy, both national and European, for the design, production and acquisition of unmanned aerial vehicles (UAVs), for surveillance or combat."
- "France will support the emergence of an integrated European industrial capability for land equipment, including production of ammunition."

Remarks on the market
The French government will maintain its active role in export of defence equipment for reasons of both armaments control and economic aspects, as can be seen in the quote from the website of the French Délégation Générale pour l'Armament (DGA) in a paragraph on export of arms:
"Contribuer activement à ce volet majeur de la politique industrielle tant sur l'aspect contrôle pour le respect des engagements internationaux de la France que sur l'aspect économique pour le développement des entreprises de défense."

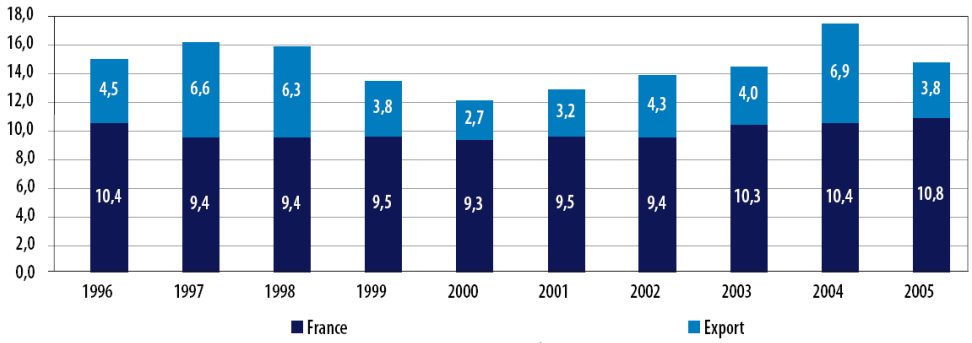
And in Chapter 16 of the White Paper (p.279) :"La France est un acteur majeur sur le marché international de l'armement. Les exportations constituent un volet essentiel de la stratégie industrielle du pays. Elles permettent d'allonger les séries et de réduire, ou à tout le moins de limiter, le coût unitaire des matériels commandés par l'État. Elles rendent les entreprises moins dépendantes du marché national, tout en contribuant au maintien de leurs compétences."

Remarks on the State / Defence Industry Relationship
The white Paper underlines that the creation of a European defence industry base should require the renewal of the State / Defence Industry relationship. For the french State, that means to favour a "logic of influence" on the industry : "*D'une logique de détention patrimoniale des entreprises, l'État évoluera, autant que de besoin, vers une*

logique d'influence sur les comportements des acteurs industriels. En effet, l'État dispose de nombreux instruments qui lui permettent de peser directement sur les orientations stratégiques des entreprises dont il est client : en particulier l'importance du chiffre d'affaires qu'il représente, la mise en place de partenariats public-privé, ou le soutien institutionnel qu'il met en œuvre."(p.281)

The french defence industry base generates 165 000 direct employments and 14,6 bn€ sales in 2005 (of which 3,8 bn€ of export sales).

Sales France / Export (1996-2005, bn€)



(Annuaire statistique de la défense 2007-2008)

French orders by type of material (m€)

	2000	2002	2004	2006
Artillery, munitions	256	113	60	405
Missiles, radars	1726	384	1004	1218
Vehicles, battle tank	28	181	105	70
Detection, NBC protection	5	16	12	15
Surface vessels, submarines	1191	1137	166	463
Military aircraft, helicopters, UAV	2778	1168	1281	2740
Transmission, countermeasure	692	496	532	488
Others	234	259	223	345
TOTAL	6910	3754	3382	5744

(Annuaire statistique de la défense 2007-2008)

Main French arms producers

Name	2006 Sales (m€)	Employ-ment	State Share-holding	Main activities	Main Military Programs
Dassault Aviation	3300	11928	-	52% Military aircraft 48% Civil aircraft	ATL2, Mirage 2000D, Mirage 2000DA, Mirage 2000-5, 2000N, 2000-9 (export), Alphajet, Rafale, UCAV nEUROn
DCNS	2707	12556	75%	58 % naval hipbuilding 30 % support 12 % equipments	Force projection vessels (Mistral Family LHD); SSBN (Le Triomphant Class); SSN Barracuda ; SSK Scorpène, Andrasta ; Frigates FREMM, Horizon, Delta (Singapour), Sawari II (Saudi Arabia) ; Anti submarine warfare (MU90 lightweight torpedo) ; naval combat systems
Nexter	720	2491	99,9%	86 % Systems 13,5 % Munitions 0,5 % Support	Artillery and equipments : the CAESAR®, 155 AUF1 TA and 105 LG1 artillery systems ; weapons and turrets (weapons systems for the Army, Air Force or Navy, to armaments and equipment for ground force armoured systems: FELIN and FAMAS) ; infantry fighting vehicles

					and systems (VBCI, Upgraded AMX 10P) ; tracked or wheeled armoured systems (Leclerc main battle tank, modernised AMX 10RC) ; artillery, tank, and medium-calibre ammunition (90mm, 105mm or 120mm tank ammunition ; NATO standard 105mm and 155mm rounds and 100mm Naval rounds; precision anti-tank round Bonus), basic pyrotechnic components and subassemblies to manufacturers of missiles, rockets, fuses, torpedoes ; tactical level information and battlefield management systems
Safran	11300	61400	State : 30,8% Public sector : 7,4%	19 % Communication 13 % Defence ans security 45 % Aerospace propulsion 23 % aircraft equipment	navigation and inertial guidance equipment, optronic systems and equipment, avionics systems, UAV systems (Crecerelle, SPERWER / SDTI (3 versions), UGGLAN, HORUS-SD), air-land systems and equipment, biometric identification systems ; Military aircraft engines (Atar, M 53, M 88, Tyne, Larzac, Adour, TP400) ; Propulsion (Vulcain, HM7, Mistral, M45, M51, Vinci)
SNPE	686	4296	99,9%	26,7 % fine chemicals 46,5 % energetic materials 14,3 % chemicals specialties 4,3 % Explosives 7,9 % industrial explosives 0,42 % others	Propulsion : strategic (M45, M51), space (Ariane 5), tactic (ASMP-A, Aster, Mica, LRM NG, Exocet) ; Propellants grains and energetic subsystems Naval (explosives : Mica, Exocet, Scalp EG, LRM NG).
Thales	10264	53400	1 *golden share* Public Sector : 27.29%	15,5 % Air systems 24 % Aerospace 23,4 % Land & Joint Systems 13 % Naval 11,7 % Security 12 % Services	Rafale, SIC2, Syracuse, Martha, OE Sic Terre, FSAF phase 3, Frigates Horizon and Sawari II, SSK Scorpène, helicopter NH90, Shola 2, K-SAM, Mirage 2000-9, Tigre, Meltem, Starstreak Missiles, VT1 Missiles, sonars 2076, Astute, BGTI, etc.

(SGA, DGA, 2007)

Position of France vs EDTIB strategy summarised

Key actions for governments to bring about EDTIB	French situation (Mostly from the white paper)
Clarifying priorities Which key technologies do we need and which industrial capabilities do we have and need.	'Nuclear deterrence; ballistic missiles; SSNs; and cyber-security are amongst the priorities.' […] 'This requires the modernisation of two components: the sea-based ballistic missile submarine force and the airborne missiles carried by nuclear-capable combat aircraft.' […] 'France is particularly active in the fight against the proliferation of chemical, biological and nuclear weapons as well as the delivery missiles.' Priorities:

	• Nuclear systems (The capability to design, develop and produce nuclear weapons, as well as ensuring their safety and reliability) • Space systems (France is the only European country to have developed ballistic missiles) • Naval systems (Submarine capabilities are of strategic importance) • Aeronautics systems (France will support the inception of a European military aircraft manufacturer capable of designing future combat systems, manned or unmanned) • Land systems (France will support the emergence of an integrated European industrial capability for land equipment) • Missile systems (France will ensure the continued existence of European capabilities in this sector, based on Franco-British cooperation) • Security of information (France will launch and support an industrial strategy leading to a significant increase in national capabilities of design and production in the field of information system security.) • Electronic components in the defence sector (The national and European technological and industrial base for defence electronic components is fragmented […] rance will support a European approach conducive to the emergence of a European industrial base. 'The White Paper also calls for the launching of new programmes, during the same timeframe, in particular in the field of knowledge and anticipation (knowledge-based security, observation, electronic intelligence, early warning) on land, at sea and in the air with the development of surveillance and armed drones, as well as both offensive and defensive cyberwar capabilities.'[..] 'Reinforcing resilience requires a change in the means and methods of surveillance used over the national territory including land, sea, air and now space and to develop a more rapid and wider in scope, response capability for French public authorities. Communication and information systems and civil warning systems lie at the centre of the crisis management and preparedness system.' […] '[The] French strategy in a 15-year perspective, embracing both defence and national security. It includes foreign security and domestic security, military and civilian means, tools and approaches.' […] 'A national security strategy is defined in order to provide responses to "all the risks and threats which could endanger the life of the Nation." […]
Consolidating demand Effective national processes are required to ensure that the collaborative option is always considered in our procurement decisions.	'The defence industry must be European in order for its companies to become competitive worldwide.' […]

Increasing investments Spend more, spend better and spend more together on Defence R&T	'France shall devote a major financial effort to its defence, consistent with the priorities and choices made for its operational capabilities. Therefore de-fence spending will not decrease.' […] "[…] during a second phase, starting in the year 2012, the budget will increase at the pace of 1% per year in volume, that is, 1% above the inflation rate. Between now and 2020, the aggregate effort devoted to defence excluding pensions will amount to 377 billion Euros.' […] "The resulting savings will be totally reinvested in the procurement budget which will increase from an average of 15.5 billion Euros in past years to 18 billion Euros on average per year for the period 2009-2020, and also in the improvement of defence personnel training and living conditions." […]
Ensuring Security of Supply Be confident that increased mutual dependence for supply of defence goods and services is matched by increased mutual assurance of that supply.	"The White Paper proposes several concrete goals for European defence in the coming years : […] Create impetus and restructure the European defence industry"
Increasing competition and cooperation (Member States in general have relied on the "national security" exception in Article 296 of the Treaty establishing the European Community to make the bulk of their defence purchases on a national basis. This has had the effect of stunting the development of a proper European Defence Equipment Market – thus denying both the customer and the industry the benefits of competition, and hindering the necessary cross-border integration of the European DTIB.) • Cross-border transfers • Offsets • Equity amongst competitors Cooperation: achieving more, and more effective, collaboration	"France believes that the European framework must be privileged: combat aircraft, drones, cruise missiles, satellites, electronic components etc., although procurement policy must include acquisitions on the world market." […] "Individual European countries can no longer master every technology and capability at national level. France must retain its areas of sovereignty, concentrated on the capability necessary for the maintenance of the strategic and political autonomy of the nation."" […] "France has no formal countertrade and offset policy, but has a countertrade and offset bureau within the Ministry of Economic Affairs & Finance and another in the MoD. France is largely self-sufficient in military supply but major acquisitions from overseas suppliers have occasionally been subject to offset requirements. In terms of multipliers, France tends to prefer transactions with small and medium-sized industrial companies. (source: Jane's Defence Industry - December 01, 2007)

B.4 Case study: Germany

Documents (and other sources)
Weissbuch 2006 zur Sicherheitspolitik Deutschlands und zur Zukunft der Bundewehr (White Paper 2006 on German Security Policy and the Future of the Bundeswehr)
See: http://www.bmvg.de for full text in German and English and summaries in German, English, French and Russian

In this country paper we first look at the German strategy in general. In the second part we will attempt to relate that strategy to the EDTIB strategy (EDA, 2007).

General
The Bundeswehr's functions are derived from its constitutional mission and from the values, goals, and interests of German security and defence policy. They are: international conflict prevention and crisis management, to include the fight against international terrorism; support of allies; protection of German territory and its citizens; rescue and evacuation operations; partnership and cooperation; subsidiary assistance (legal and administrative support, help in the wake of natural disasters and particularly grave accidents).
For the foreseeable future, the most likely tasks will be the prevention of international conflicts and crisis management, to include the fight against international terrorism. They will determine the structure of and exert significant influence on the capabilities, command and control systems, availability, and equipment of the Bundeswehr.
Internal and external security are increasingly intertwined. The defence against terrorist and other asymmetric threats within Germany falls primarily into the purview of the Federal and Land authorities responsible for internal security. It is, however, permissible under current law to deploy the Bundeswehr and its available assets whenever a particular situation cannot be managed without its assistance.

Universal conscription has shown itself to be an unqualified success for Germany, despite the changes in the security environment. Since it was introduced more than five decades ago, a defence and force structure has evolved that, through intelligent combination of regulars and temporary-career volunteers, basic-service and extended-service conscripts and reservists, ensures a high degree of professionalism and integration in society.

Remarks on EU cooperation and EC initiatives
A modern Bundeswehr requires an efficient and sustainable defence industry base. This will need to be defined increasingly in a European context, given the limited national resources and restrained national demand. Political, military and economic aspects make in-depth cooperation highly important for the EU member states to meet the materiel requirements of their armed forces. For this reason, the development of a European armaments policy is a central goal in establishing and expanding the European Security and Defence Policy.
It means having indigenous defence technology capabilities in order to co-shape the European integration process in the armaments sector. These will guarantee cooperability and assure an influence in the development, procurement and operation of critical military systems. Only nations with a strong defence industry have the appropriate clout in Alliance decisions.

An opening-up of the defence market at European level is also expected to have positive implications for the defence industry. The voluntary code relating to the application of Article 296 of the EC Treaty (Code of Conduct on Defence Procurement) entered into force on 1 July 2006 under the aegis of the European Defence Agency. It already represents an important step towards more competition and transparency in the defence industry and will, in the end, also benefit the German defence industry.
The European Commission is also working on an interpretative communication relating to the application of essential security interests within the meaning of Article 296 of the EC Treaty. The aim of the communication is greater legal certainty in the application of this Article.

Remarks on Demand side
The current medium-term financial planning provides for annual growth of the defence budget. Only such a budget line will guarantee the transformation of the Bundeswehr and enable Germany to meet its international commitments to establish joint capabilities both at a European level and in the transatlantic alliance, and to carry out its international operations. Taking military expenditure over the past 20 years as an indicator of the development of the defence budget, it seems to imply a reversal of developments.

Military Expenditure of Germany		
Year	in constant (2005) US$ m.	% of GDP
1988	55,627	2.9
1989	55,475	2.8
1990	58,464	2.8
1991	55,134	2.2
1992	52,436	2.0
1993	47,139	1.9
1994	43,962	1.7
1995	43,238	1.6
1996	42,395	1.6
1997	40,854	1.5
1998	40,993	1.5
1999	41,822	1.5
2000	41,147	1.5
2001	40,474	1.5
2002	40,604	1.5
2003	40,044	1.4
2004	38,816	1.4
2005	38,060	1.4
2006	37,133	1.3
2007	36,929	*

The reorientation of the defence budget, in particular the reallocation of funds from running costs to investments, will provide an adequate financial basis for the transformation. A multitude of measures are helping to reduce operating expenditure. They essentially include further personnel cutbacks, the new stationing concept, materiel and equipment planning, and continued stripping-out of bureaucracy.

Remarks on Supply side
The reduction of operating expenditure will serve to increase the defence investment expenditure share of the defence budget. The 30 percent investment ratio set partly as a target in the past is rendered out of date by the estimate of the proportionate pensions and benefits expenditure in the defence budget.

Remarks on Market place
The political leadership and industry must jointly define the strategic positioning of German defence technology in Europe. The Federal Government will do its utmost in this regard to preserve a balanced mix of defence technology, including its high-technology areas, in Germany. National consolidation, such as is taking place in the shipbuilding industry, is preparing Germany's defence technology enterprises to suitably position themselves for the restructuring process in Europe.
By developing interministerial strategies and continuing our dialogue with industry, we are looking to preserve competitive industrial capabilities in key technology areas of the German defence industry as part of a balanced European partnership.

National Position and EDTIB-Strategy

Key actions for governments to bring about EDTIB	German situation
Clarifying priorities Which key technologies do we need and which industrial capabilities do we have and need.	Germany has clear ideas about its priorities and necessary technologies. Her priorities for defence operations focus much on conflict prevention, fight on terrorism and assistance and rescue operations. The key technologies will be needed in surveillance, data analysis, logistics (especially logistic planning, airlift and land vehicles) and capabilities to protect information (systems). (Source: Bundeswehr White Paper 2006)
Consolidating demand Effective national processes are required to ensure that the collaborative option is always considered in our procurement decisions.	According to the White Paper, Germany finds solitary procurement increasingly difficult. The German MoD thinks that an opening-up of the defence market is expected to have positive effects for the defence industry. According to an EADS presentation at the 7th Congress on European Security and Defence 2008, Germany will become increasingly dependent on US imports if the national defence industrial base is further weakened. (Sources: Andreas Hammer, EADS Head of Key Account Germany at 7th Congress on European Security and Defence Berlin, 11 November 2008 / SIPRI Database 2009 / Bundeswehr White Paper 2006)
Increasing investments Spend more, spend better and spend	According to the statements in the Bundeswehr White Paper,

more together on Defence R&T	Germany's national resources for defence are limited and defence budgets have decreased from 55.6 bn. US$ in 1988 to 36.9 bn. US$ in 2007 (SIPRI). According to the mentioned EADS presentation, the German defence budget declined by nearly 50% since 1998 and is not likely to reach the 1989 nominal level until 2012. The decrease in defence-related R&D expenditures will also continue to decrease. The financial risk for risky R&D is much higher in Germany than in many other European countries or the US. (Sources: Andreas Hammer, EADS Head of Key Account Germany at 7th Congress on European Security and Defence Berlin, 11 November 2008 / SIPRI Database 2009 / Bundeswehr White Paper 2006)
Ensuring Security of Supply Be confident that increased mutual dependence for supply of defence goods and services is matched by increased mutual assurance of that supply.	It is getting increasingly difficult to aggregate the necessary resources for defence alone. According to the EADS presentation, Germany has no longer the financial resources to sufficiently procure defence equipment on a domestic basis and equip the armed forces. Only European cooperation, a pooling of resources and a concentration on ones respective strength, i.e. a A strong defence industrial base in Europe could make Europe competitive with the US and emerging Asian countries. (Sources: Andreas Hammer, EADS Head of Key Account Germany at 7th Congress on European Security and Defence Berlin, 11 November 2008 / SIPRI Database 2009 / Bundeswehr White Paper 2006)
Increasing competition and cooperation Cooperation: achieving more, and more effective, collaboration • Cross-border transfers • Offsets • Equity amongst competitors • Article 296	Germany is calling for more co-operation and more open European procurement. This also necessitates common security interests and trust in the partners (EADS). This requires the removal of obstacles, especially offsets and 'juste retour' (EADS). Germany does not demand offsets, but often suffers financial disadvantages because of this. According to EADS the EDTIB should not be a sum of national DTIBs but a unified sourcing pool of clusters of excellence concentrating on specific products. This would lead to cost reductions and constructive competition. (Sources: Andreas Hammer, EADS Head of Key Account Germany at 7th Congress on European Security and Defence Berlin, 11 November 2008 / SIPRI Database 2009 / Bundeswehr White Paper 2006)

B.5 Case study: Poland

Polish Arms Industry – time for reconsolidation[24]

Evolving national Security context

The security sector in Poland is constantly changing. From the post-Cold War period through the NATO accession process to the current bilateral model two major streams are apparent:

- Rebuilding homeland defence / security (modernization and restructuring of Polish Armed Forces).
- Gaining abilities for operating abroad (peace-keeping missions and taking part in the "global war on terrorism").

The arms industry in Poland is one of the major parties involved in army modernization process and in the dialogue for the future vision of Polish Armed Forces.

Poland is actively involved in the global war against terrorism. It is an active NATO member supporting Alliance (expeditionary) missions and deems a strong link between USA and Europe as important. Poland is focused on NATO- and US–lead initiatives. Poland is shaping its position in global security policy as a close partner of the USA. Placing NBMD missile sites and rebuilding air defence seems to be key issues, influencing on neighbouring relations with both EU and Russia. After the elections of 2007, Polish Parliament seems to be more EU orientated.

One of the most important challenges in Poland's security agenda is to provide an equal dialogue with Russia, especially in matters concerning Post-Soviet areas and zones of influence. It is very important to create common security environment in Northern and Eastern Europe. From a Polish perspective two areas are crucial:

- North (Baltic States, Scandinavia and Germany).
- South East Czech Republic Slovakia Hungary).

Poland is finalizing its post Cold War transformation and currently developing its own expeditionary abilities:

- Strategic airlift.
- Naval support (Gawron class multirole corvettes, submarine support capabilities).
- IED secured platforms such as LMV TUR Heavy wheeled patrol vehicle •ubr and specially tuned ROSOMAK towed APC (based on AMV Patria).
- Redesigning personal infantry equipment (first step towards future infantry combat system).

Poland will support European defence capabilities by:

- Supporting EDA defence projects.
- Supporting EU Battle groups.
- Taking a part in EU related R&D projects.

[24] This case study was prepared by Jakub Link-Lenczowski of the Krakow's Institute for Foreign Affairs on an assignment by TNO within the framework of the Study. Sources used: Ministry of Defense, Ministry for Foreign Affairs, Ministry of Economy, Raport WTO, own research.

State of play in the arms industry

On the basis of a broader security strategy, the Polish defence industry has been consolidated. Currently the key player in Poland is the (private) Bumar Group, comprised of both manufacturers and R&D centres. Some of former state owned and controlled companies have become a part of the (governmental) Industrial Development Agency (IDA). The integration process is one of the most important factors in order to create a sound financial basis. The Bumar Group, in 2002 still suffering a loss of 8,5 million zloty , has been generating profits since 2004: 17,4 million zloty in 2004; 15,2 million zloty in 2005; and 17 million zloty in 2006. Sales of military equipment manufactured in Poland increased from 0,4-0,9 billion zloty to over 2,5 billion zloty.

Manufacturer	Turnover (mln zloty)			Employment			Net result (mln zloty)		
	2006	2005	2004	2006	2005	2004	2006	2005	2004
ZM Bumar •ab•dy	632,94	642,67	213,19	857	848	753	10,58	7,61	11,77
PZL •widnik	325,09	316,50	237,95	3 470	3 263	2 757	1,25	0,96	6,99
ZM Mesko	265,55	179,07	140,80	1 771*	1 596	1 555	0,69	38,30	0,07
HSW	228,12	195,81	331,11	1 434	1 368	1 228	81,19	28,05	-32,38
AZPB Andropol	200,90	n/a	n/a	199	n/a	n/a	0,53	n/a	n/a
AMZ Kutno	159,87	n/a	n/a	450	n/a	n/a	n/a	n/a	n/a
CNPEP Radwar	150,44	117,32	134,82	1 642	1 282	1 290	5,22	4,45	7,26
PPH Kama	134,00	35,90	56,70	n/a	112	n/a	9,8	0,44	6,5
Radmor	89,00	73,99	75,58	n/a	402	411	6,8	8,56	1,04
PCO	76,80	51,65	50,73	414	405	411	5,15	2,02	4,30
DGT	74,00	60,10	80,63	219	124	122	n/a	2,38	0,75
PSO Maskpol	73,03	59,72	65,29	714	541	528	9,12	8,00	8,80
WSK PZL Kalisz	68,61	69,19	63,89	1 053	1 039	1 030	0,40	0,25	-1,86
ZM Dezamet	63,69	48,71	70,04	620*	533	535	3,38	2,97	5,82
ZM Tarnów	61,18	61,41	47,74	822	921	865	0,17	-2,86	1,40
ZCh Nitro-Chem	50,86	41,13	n/a	270*	261	n/a	-0,25	-3,05	n/a
PZL Hydral	48,62	47,60	34,65	641	635	643	-1,08	-14,93	-48,15
Transbit	45,44	82,01	31,34	104	99	90	16,77	22,35	14,49
WB Electronics	43,53	25,81	21,80	54	47	39	11,32	7,59	4,02
MAW Telecom Intl.	41,28	n/a	n/a	14	n/a	n/a	2,31	n/a	n/a
PZL Wola	40,75	47,05	n/a	601*	346	n/a	3,49	-19,00	n/a
Lubawa	38,31	25,12	30,26	258	n/a	254	7,56	5,24	3,05
WSK PZL Warszawa II	35,72	31,45	22,07	376	349	344	1,45	2,75	1,67
LZPS Protektor	35,60	27,05	n/a	n/a	468	n/a	2,85	0,45	n/a
FB •ucznik	30,14	34,50	28,04	374	333	264	1,46	1,60	1,33
ZPS Pionki	22,58	24,98	28,61	190	187	205	0,32	0,73	-1,46
FPS Bolechow	21,22	17,29	23,06	104	101	98	0,33	0,05	n/a
PBP Enamor	17,93	13,01	9,36	54	49	50	1,97	1,25	0,29
SPWS Kili•ski	12,00	9,28	n/a	105	100	n/a	0,25	0,06	n/a
Prexer	9,76	9,59	9,32	135	132	125	0,55	0,45	0,52
Air-Pol	9,70	5,73	6,50	40	33	37	0,95	0,89	1,58
Marga•ski & Mys•owski	3,82	n/a	n/a	34	n/a	n/a	-3,2	n/a	n/a

Manufacturer	Turnover (mln zloty)			Employment			Net result (mln zloty)		
	2006	2005	2004	2006	2005	2004	2006	2005	2004
Aero	2,1	n/a	n/a	25	n/a	n/a	-0,2	n/a	n/a

The main priority for the arms sector is to provide support for the Armed Forces during the in-service phase of military equipment; and R&D in the field of missiles (rockets) and ammunition, explosives, personal weapons and equipment. R&D support will be organized in four separate segments. One segment will be run by the ministry of Defence (ITWL, WITU, WITPiS, WITI, WI•, WIChiR), another by the ministry of Economic Affairs (OBR CTM, PIT, IL, IPO). ITB Moratex will be under the supervision of ministry of the Interior. The last two groups are designated to provide close cooperation with Bumar Group (OBRSM and OBRUM).
Future (national) consolidation is stopped because of the acquisition of PZL Warszawa-Ok•cie, WSK PZL Rzeszów and PZL in Mielec by foreign investors.

According to recent analyses these are the factors accounting for the present growth:

- The Polish military presence in Iraq and Afghanistan.
- Contracts signed by the Bumar Group (mostly in Iraq and Malaysia).
- The urgent need to provide the army with a new generation of multirole fighting vehicles: APC, IFV, MBT.
- The urgent need to provide the navy with new types of vessels: multirole corvette, AIP submarines,; and to provide major modernization for some which are currently in the service.
- The urgent need to replace most transport helicopters in the army and navy, both medium and heavy lift.

Of these factors, the arms sales to the New Iraqi army (NIA) and the fast-track acquisition of necessary equipment for the Polish troops abroad are the most important. In the near future the turnover will probably decrease. Supporting R&D centres (as a part of broader European and Trans-Atlantic network) will be crucial for future development.

Looking ahead

In the future (until 2012) the Bumar Group will be the leader and integrator of the arms industry In Poland. IDA companies will be privatized and will probably become a part of Bumar Group. During 2008 ZM Kra•nik and Radmor will become a part of the Bumar Group. The following military workshops will be commercialized: WZE, WZI, WZ• -1, -2, WZM-5, WZM-S (armour vehicles), WZL-1, -2, -4 (aviation) and OBRUM. WSK PZL • widnik, WSK PZL Kalisz and PZL-Hydral must find strategic investors before the end of 2009. Some enterprises regarded crucial for the national defence will stay beyond Bumar (Stalowa Wola steel mill).
The Bumar Group will have three major divisions:

- Ammunition and missiles.
- Armour and optic-electronics.
- Technical support (workshops).

R&D centres will provide direct support for all of these divisions. In 2012 Bumar might become a joint stock company. It is suspected that 2,5 billion zloty will be spent for R&D. Export still will be the most important factor generating income. Turnover in the domestic market will decrease from 2.5 billion zloty to 2.1 billion zloty in 2012.

Key equipment to be purchased by Polish Armed Forces In the nearest future:

- Small Unmanned Aerial Vehicles (mini-UAVs).
- Automatic grenade launchers + ammunition.
- External armour for Rosomak APS (currently purchasing in Israel).
- Implementing mine and IED protected light modular vehicles (like Tur LMV).
- Acoustic detectors (Pilar type – some of them are already deployed in Afghanistan as a part of towed Rosomak protection system).
- Cal. 30 mm ammunition for towed APC.

Current modernization programmes for the Polish Armed Forces:

- APC Rosomak.
- Spike anti-armour missiles.
- Communication equipment: mobile RW• C-10T system, radio communication platforms for vehicles and personal radio receivers, satellite transmitters.
- Multi-role fighter F-16.
- Medium airlift CASA C295M.
- Multi-role corvette Gawron.
- Rocket system • eglarek.

Key modernization programmes for the Polish Armed Forces projected for the future:

- Implementing new command, control and communication systems and battlefield management applications.
- Implementing new reconnaissance systems.
- Implementing new WMD protection systems and equipment.
- Implementing new medium and heavy airlift capabilities.
- Acquiring Unmanned Aerial Vehicles (mini-UAVs).
- Development of military geography, cartography and naval hydrography.
- Infantry individual equipment.
- Acquiring new vessels and sea based equipment.
- Personal warfare systems (Soldier of XXI century).
- Anti aircraft systems.
- Medium range radiolocation systems.
- Air and missile defence capabilities for naval vessels.
- Digital systems for reconnaissance data gathering, processing, analyzing, storage and distribution.

In the field of European cooperation the key issue is to provide as many of R&D programmes as it possible. Other important issue are strategic airlift, refuelling in the air, WMD protection, joint communication, intelligence and command centres. All of them are complementary to ESDP and aimed at fulfilling the EDA goals to support EU defence capabilities such as EU Battle Groups.
The main Polish contribution for European joint security are:

- Over 10 mln Euro for EU security programs (Force Protection 2007 - 2009).
- Participation in four B-class projects (over 13mln Euro during the period 2008-2010):
  - √ European Secured Programmable Radio.
  - √ Network-Enabled Armoured Fighting Vehicle.
  - √ Unmanned Ground Tactical Vehicle.
  - √ Creating and supervising of the biological threats database.

B.6 Case study; Sweden

The Swedish upcoming Defence Industrial Strategy and its Implications for the EDEM and EDTIB

Introduction

Sweden does not have a defence industrial strategy. There will probably be a defence industrial strategy launched in 2009. The Armed Forces are presently doing a fundamental revision of its vision for ISTAR and NEC, and this ongoing revision (together with an upcoming defence industrial strategy) means that there are not at present sufficiently valid definitions or documents for ISTAR and NEC.

The MoD initiated in June 2007 the creation of a Defence Industry Strategy. This was intended to be finalised during 2008, but will probably be presented during 2009. The outcome, scope and level of detail of this strategy are at present unclear. The MoD states that this strategy will be steered by the operative demands of the Armed Forces. This means that the increasing participation in international operations is prioritised, and thereby interoperability. Furthermore that lead times and economic long term commitments must decrease. The directions for the Defence Industry Strategy underline the defence and security policy benefits, as well as a technology and innovation potential, of a domestic defence industry, but it also stresses that Sweden increasingly must acquire more from abroad as well as upgrade existing defence materiel in a more efficient way.

It can be expected that the upcoming Swedish defence industrial strategy will further underline the Swedish course since a few years to decrease the sovereignty ambitions and to narrow down the technologies that are seen as prioritised.

The implications for the development of the EDEM and the EDTIB are therefore difficult to specify. Furthermore, as the Swedish defence industrial posture has clearly been decreased in the past years, the overall contribution cannot be expected to be dramatic.

Preliminary features of the Swedish Defence Industrial Strategy

Defence budgets have in the last years fallen - both as a total sum, but percentage-wise even more so in defence R&D and procurement. The present rightwing ruling coalition (2006-2010) has down-prioritized the defence budget in favour of other government budgets. Substantial defence finances have been moved from defence R&D and procurement towards securing key capabilities for international operations.

As a result of this, there is presently an ongoing overview of prioritizing which defence-industrial capabilities to support, and which that will be largely left to their own competitiveness. Within the Defence Research Establishment (FOI) and within the Procurement Agency (FMV) as well as the Armed Forces, there have been areas of defence technology where the ambitions have been clearly lowered. The ambition is to steer the R&D towards more bi- or multilateral defence collaboration. Defence procurement is to be spent in the following priority:

- Procurement of already developed defence materiel (“off-the-shelf”)
- In bi- or multilateral defence materiel development.

- As the last and exceptional alternative, an only-Swedish development.

This priority list has been advocated for many years, but became official military policy by the Defence Materiel Acquisition Policy (2006). In relation to the actual procurement behaviour, this can be understood as a radical shift.
One could say that there has been one major test of this policy. BAE Hägglunds had developed an armoured vehicle project; SEP. Sweden was not prepared to further fund this project. The UK had SEP as an alternative for its FRES program. This would have meant that Sweden and the UK mutually would have financed SEP (i.e. alt. 2 above), if the UK would have opted for SEP. However, SEP was not chosen. Sweden followed its policy, and chose not to further fund SEP. A similar case is the Kockums submarine program Viking, which (under a new acronym) did receive further all-Swedish funding. This is however of a time-limited nature, thereby falling under alternative 3.
As a result of decreased defence R&D and procurement in Sweden, the government has decided to increase support from concerned authorities for "export support", i.e. primarily personnel resources from Armed Forces, ministries, FMV and FOI. Thereby the export potential is intended to be increased.
Probably, there will be a major reform in 2009 concerning defence R&D and procurement, paired with the new Defence Industry Strategy. This process has however been postponed/ prolonged in the last two years.
The power-balance over defence matters has in recent years clearly shifted from the Armed Forces and the MoD, giving more power to the Ministry of Finance. This is a deliberate shift from the present government.
FMV, FOI and the Armed Forces have since 2006 co-located central planning functions in a common function called Integrated Defence Materiel Management (IML, *Integrerad Materielledning*). Within IML, these military services are to coordinate and harmonise the defence research, defence procurement and military demands.

Current Military Status
In the last five years, the focus has clearly shifted towards international operations. In the second half of 2008, however, there has been a step back towards territorial defence (Sweden), due to the increased military posture of Russia and the war in Georgia.
One current pressing demand is strategic transport capability, especially in relation to international operations.
The continued work with the EU Crisis Management Capability is an important starting point for the future Swedish defence. Deficiencies (as e.g. strategic transport capability) have been identified within the EU *Headline Goal 2010*, and these are guiding for corrections and future procurement.

ISTAR
Sweden started in 1999 an ambitious campaign towards network-centric capabilities called NBF (*Nätverksbaserat försvar*). The Swedish posture, ambition and understanding of ISTAR is strongly research-based, and Sweden is highly involved in several international consortia or networks concerning network-enabled capabilities with the most advanced nations.
Sweden has a highly developed non-defence telecommunications sector, with Ericsson as the motor. They are however not overly engaged in specific defence technology, but there is a developed bio-diversity of
SMEs in related technologies.

There was an overarching decision a few years ago that stated that Networked Enabled Capabilities (NEC) shall be seen as a natural and self-evident component in practically all operations.
Saab Systems, Saab Tech and Sectra are companies that are successful in the information, command and control sector.

Defence industrial base
Sweden has for its size a highly developed defence supply base. Bofors has since the 19th century been an internationally successful company in artillery. After WWII, and all through the Cold War, Sweden had high ambitions of being largely self-sufficient in supply of defence equipment. At the end of the Cold War, Sweden therefore had for its size a very broad and advanced defence supply base. Sweden was self-sufficient in fighters, submarines, armoured vehicles and naval vessels, just to name the more costly. Also in command and control, missiles and torpedoes, Sweden was quite developed. This supply base was supported for a number of years after the Cold War. After a few years of fretting, Sweden has in the last five years or so clearly cut down on its defence R&D and its defence procurement. There is therefore at present a defence industry size and breadth which cannot be withheld only by Swedish defence funds, and they must to the most part survive by their self-generated international competitiveness and export.
Sweden was early in adopting an openness towards foreign investments/acquisitions in the Swedish defence industry. From the mid 90s, Bofors (artillery, munitions), Hägglunds (armoured vehicles), Kockums (naval vessels and submarines) have all been acquired by foreign companies. BAE Systems acquired 35 % of Saab Group, but this ownership was decreased to 20 % in 2008. Bofors and Hägglunds are owned by BAE Systems, and Kockums by Thyssen Krupp Marine Systems.
The Swedish larger companies have solid support from the defence-related authorities and are well established in the domestic networks.
SMEs used to receive more solid support from defence R&D, but have generally suffered tighter margins with shrinking funds.
The present defence industry in Sweden is dominated by Saab Group, which is a highly conglomerate group. It acquired Ericsson Microwave Systems from Ericsson in 2006, thereby acquiring radar, sensor and microwave technology.
Apart from the above mentioned companies, there is also Volvo Aero, which produces jet engines. It used to make license-produced jet engines for Swedish fighters and was primarily a military company. Presently, they are not assembling entire engines; they are primarily a system supplier to international consortia behind certain jet engines for commercial aircraft. Presently, their military turnover is about 15 %.

The Swedish identified 'key' defence industrial capabilities
Presently, there is no official policy on what are the prioritised capabilities or industrial capacities. There was from 2004 to 2006 a MoD-initiated assessment of national industrial capabilities, and from that study there were a suggestion of industrial niches. This result has since been downplayed due to changing political priorities and a new government. The entire process of defining capabilities and niches has shifted from a military and defence matter to a much more political nature since 2004. A *preliminary*, but provisional list of Swedish prioritised defence industrial capabilities/niches would be the following:

- Network-based command and control systems,
- Aircraft,
- Combat vehicle systems,

- Short-range combat systems and
- Unjammable telecommunication systems.

These areas also include interfunctional sensor and data fusion as well as signature, protection and system design. Out of these five areas, the 'aircraft'capability (i.e. Gripen) has in government bills and decisions clearly been proven to be prioritised.

Current and future Swedish defence spending
Air systems (for the Gripen) is the largest spending sector. Gripen is the only large defence technology area which clearly has been assigned future priority. Most of this capability is centred in Saab's Linköping facility. Parts of the systems developments for Gripen is in a longer perspective likely to be shared to some extent with defence companies in Gripen-acquiring nations through offset-induced partnerships.
Land systems and sea systems are likely to be acquired to a larger extent "off the shelf" or through arms cooperation with other nations (as outlined by the Defence Materiel Acquisition Strategy).
In land systems, Sweden has two companies that develop their own platforms and systems: BAE Systems Hägglunds (armoured vehicles) and BAE Systems Bofors (grenades, guided munition and artillery systems). The last years procurement decisions, in line with the Defence Materiel Acquisition Strategy, point to that there will not be further indigenously developed armoured vehicles or artillery systems.
The most pressing procurement need is for the continuous upgrading and maintenance of forces for international operations, which to the most parts concern army land forces.
Kockums (Owned by Thyssen Krupp Marine Systems) has a capability to produce conventional submarines and medium-sized naval vessels. There has not, however, been any substantial new submarine development for many years. The naval vessels are also under narrow Swedish spending, and Kockums have not been able to export the latest vessel, the Visby.
The key defence industrial capabilities which certainly will be retained in Sweden are key technologies for the Gripen system. Further technologies that can be highly expected to be retained are cryptographic technologies, certain electronic countermeasures and jamming.
If we speculate on which parts of the Swedish defence industry that in 15 years will have a firm footprint the EDTIB, it will certainly be fixed wing aircraft (fighters and UCAVs); it will probably be armoured fighting vehicles, artillery, NEC and ISTAR-related technologies, command and control systems, combat training systems (Saab Training Systems); somewhat less probably submarines (in Thyssen Krupp Marine Systems), artillery systems. Outside of that, the companies will probably have to rely on their own competitiveness and/or that they survive under the umbrella of foreign owners.
Since there is no Defence Industrial Strategy yet, and the political conditions under which it is presently negotiated are not so clear, it is not possible to be more exact.
Since Sweden is not planning to retain all present capabilities, or not retain them at the present industrial level, Sweden will probably be open and willing to participate in EU-based discussions on pan-European solutions for different solutions for centres of excellence.

The Swedish defence industry: A Three Cs Assessment
Capability-driven focuses on meeting future operational requirements of Sweden's Armed Forces whilst sustaining the necessary levels of European and national operational sovereignty. For the most part, Swedish defence companies are to a lesser

extent than the other LOI nations' industries incorporated and integrated in multilateral European defence collaborations. This is mostly due to that Italy, Spain, France, Germany and the UK have strong traditions since the 50s of partnering in large defence programs in smaller groups of nations (2-3) or through NATO.

- *Fixed wing aircraft*: Saab Group is the Swedish national monopoly supplier and it is involved in developing and producing the Gripen and the Neuron UCAV together with France The present defence policy has stated that Sweden does not expect to build a new generation of manned fast jet aircraft beyond the Gripen, but it will need a through-life capability management for it. A large share of the Gripen-based systems are US- (mainly) and UK-developed systems.

- Volvo Aero has supplied engines for a number of Swedish-developed fighters, all engines under license with some domestic development, from Rolls Royce, Pratt & Whitney and now General Electric. This military development capacity has been decreased for a number of years, and since the Gripen has now had its final Swedish delivery, the military engine capacity is further weakened. Foreign buyers tend to have other engine suppliers and maintenance operators. There are Swedish suppliers of avionics and jamming systems (inside Saab).

- *Missiles* are supplied by Saab Bofors Dynamics to some extent. Raytheon is an important supplier of air-based missiles. Saab Bofors Dynamics has a range of developed land and sea-based missiles, but there is limited development of indigenous missile programs. Sweden is a partner in the Meteor air-to-air missile.

- *Land systems*. As described above, Hägglunds and Bofors are owned by BAE Systems, through its US-based Land Systems unit. There are also a smaller number of small companies for land systems.

- *The Swedish warship industry* provides a domestic capability in conventional submarines and a specialised vessel capability in medium-sized vessels. Kockums has specialised in stealth for vessels and submarines, composite vessels and air-independent propulsion for submarines.

- *The Swedish defence electronics sector* embraces a variety of capabilities inside Saab: command and control, jamming and electronic counter measures, sensors, NEC, and more. Saab has also a strong development in South Africa in avionics and jamming through its South African subsidiary Grintek.

Competent denoting especially the rapid exploitation of the best technologies. Sweden has for its size an unusually large defence industry covering a large breadth. It has also had a strong defence research community. Due to a series of revisions of defence policy in the last decade, the defence research has been clearly decreased. Resources have primarily been redistributed towards creating and sustaining capabilities for international operations, e.g. the Nordic Battle Group and missions in Bosnia, Afghanistan and Africa.

Competitive both within and outside Europe. The Swedish defence industry is a major exporter of defence equipment, especially of fighters, armoured fighting vehicles, airborne reconnaissance (Erieye), command and control, missiles, hand held artillery and missiles, avionics, artillery systems, training systems and to some extent submarines. The Gripen dominates the export. Some of the Gripen export has been

through agreements between the Swedish procurement agency and Air Force on the Swedish side (Czech Republic, Hungary and Thailand). This is due to that the Swedish Air Force has procured more Gripens than what is presently required. Swedish defence companies have in recent years been less successful in exporting vessels, torpedoes and radar systems.

Recent export successes and potential export.
As stated above, Gripen has become the centre of the Swedish defence materiel process. It receives considerable support from the military and several Swedish authorities and ministries. It has been sold to South Africa and Thailand, and will be leased by the Czech Republic and Hungary. Present export negotiations under way are in Brazil, India, Denmark and a few others.
Saab has sold its Erieye (airborne warning and surveillance) to Greece, Mexico and Pakistan.
Saab Bofors Dynamics has continuous exports of several missile systems.
Saab Barracuda has been very successful in selling camouflage equipment to the US Army.
Saab Training Systems has been successful in exporting simulation training systems, some systems used in Iraq.
Hägglunds has for a long time had continuous export successes of their smaller armoured vehicles. They do not develop tanks.
Saab Systems in the autumn of 2008 received a substantial order to the Canadian Navy for an artillery guiding system.
Sectra has had export successes with cryptography for communication.

Swedish defence industry supply chains. This is an aspect that is not mapped or identified. Several of the Swedish defence companies have more and more become design centres that design the overall defence system, and a large part of the production of the subsystems and some development is dispersed among a network of suppliers. The core design competence is kept within the focal company, along with certain crucial systems and development functions. This refers most clearly to Bofors and Hägglunds. However, the supply chain compositions vary between defence technology areas. The design of the supply chains is up to the companies (under proper defence technology restrictions).

Conclusion
The tentative Swedish Defence Industrial Strategy makes some contribution to the development of the EDEM by recognising that in future, some of its defence equipment will be purchased from abroad. These areas of overseas purchase might also contribute to the development of an EDTIB.
The Swedish Defence Industrial Strategy faces some difficult choices, it can be summed up as that there is a serious mismatch between the size and the breadth of the defence industry compared to domestic spending and defence research – if we assume that Sweden aims to retain several strategic capabilities. A majority of the companies cannot survive on Swedish orders, and their present order book may not suffice. Thus, Sweden must make further choices to down-prioritise some defence technology capabilities.
Overall, Sweden is presently fundamentally revising its national policy in the aspects of sovereignty, spending and capabilities and the official policy in these matters is at present imprecise.

B.7 Case study: United Kingdom.

The UK Defence Industrial Strategy and its Implications for the EDEM and EDTIB

Introduction
The UK Defence Industrial Strategy (DIS) introduced in 2005 has major implications for the development of the EDEM and the EDTIB. These developments will be outlined and the UK defence industry will be assessed using a Three Cs framework for the EDTIB (EDA,2007).

Features of the UK DIS
The UK DIS identified 'key' defence industrial capabilities to be retained in the UK (Cmnd 6697, 2005). These were to be retained for (Cmnd 6697, 2005, p17):

- Appropriate operational sovereignty (operational independence; security of supply)
- Responding to Urgent Operational Requirements
- Through life capability management (with more opportunities for military outsourcing)
- Maintaining key and rapid industrial capabilities and skills
- Maintaining intelligent customer-supplier relationships

The UKs key defence industrial capabilities will be retained through MoD offering protected and guaranteed markets to preferred suppliers based on long-term partnering agreements. This reflects a shift in procurement policy from a competitive procurement policy to a protectionist policy. It is believed that a major driver for this change was pressure from BAE Systems which had incurred losses on a number of fixed price major defence projects (Astute submarines; Nimrod MR4 aircraft).

Current and future UK defence spending by major sector is shown in Table 1 on the next page. It can be seen that:

- Air systems is the largest spending sector. However, over the period 2006 to 2015, spending on fixed wing aircraft is expected to fall by almost 20% with obvious implications for reductions in production capacity in this sector of the UK aerospace industry. There are doubts about the future of two BAE aircraft plants, namely, Brough (Hawk trainer aircraft) and Woodford (Nimrod MR4).Closure of these two plants would leave BAE with two aircraft plants, namely, Warton and Samlesbury (both near Preston, Lancashire). However, there is expected to be a major increase in spending on helicopters (spending will more than double).
- Land systems is the smallest spending sector: armies are relatively cheap on equipment. There is expected to be a substantial increase in spending on AFVs.
- Spending on sea systems is expected to rise by some 36%. This reflects planned orders for Type 45 Destroyers, Astute submarines and two new aircraft carriers. The end of this new build programme will result in a major reduction in demand which will create challenges in maintaining warship building capability in the UK: eventually, there are likely to be substantial reductions in capacity.

Table 1: UK Defence Spending by Sector

Sector	Current total spend 2006/07 £ million	Future total spend 2014/15 £ million
Air Systems:		
Fixed wing	3250	2700
Rotary wing (helicopters)	750	1600
Missiles	1100	1100
Total Air	5100 (47%)	5400 (40%)
Land systems		
AFVs	300	1100
Munitions	63	70
Total Land	363 (3%)	1170 (9%)
Sea Systems Total	2800 (26%)	3800 (29%)
Electronics Sector	2300 (21%)	2500 (19%)
Aggregate Total	10793	13275

Source: DIS (2005)

Notes:

- Total spending comprises spending on equipment and support. Figures are indicative and illustrative for each sector; they are liable to change with public spending reviews. The future plans were based on the future trends as seen in 2005.
- AFVs are armoured fighting vehicles. Electronics is based on C4ISTAR which is Command, Control, Communications and Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance.
- Figures are approximations derived from data shown in graphs.
- Percentages are shares of aggregate totals.

The key defence industrial capabilities which will be retained in the UK include nuclear-powered submarines; core warship building; ammunition; and cryptography. In addition, support capabilities will be retained for fixed wing combat aircraft (Typhoon; F-35); helicopters; and armoured fighting vehicles. In effect, these areas are excluded from overseas competition and hence from the EDEM: they are Article 296 products. Also, these areas are the UKs Defence Industrial Base which will be retained within any future EDTIB. In other words, the UK has made some decisions about its DIB which are not negotiable within any future EDTIB: they form constraints on any future EDTIB but could be viewed as the UK's contribution to the future EDTIB.

Some defence industrial capabilities will not necessarily be retained in the UK with MoD reserving the option of buying from overseas. These sectors include large aircraft; trainer aircraft; helicopters; missiles; torpedoes; and where more than the core warship load is needed. These are areas where the EDEM can apply. They are also areas where the UK would accept an EDTIB capability to supply such products.

The UK defence industry: A Three Cs Assessmen

Capability-driven focuses on meeting future operational requirements of the UK's Armed Forces whilst sustaining the necessary levels of European and national operational sovereignty. The UK DIS has identified the key air, land, sea and

electronics capabilities which it seeks to retain in the UK for appropriate operational sovereignty and other reasons (these are outlined at paragraph 2 above). Most of these capabilities are national monopolies and some are foreign-owned. They include:

- *Fixed wing aircraft*: BAE Systems is the UK national monopoly supplier and it is involved in developing and producing the Eurofighter Typhoon (a four nation collaboration), the US F-35 aircraft (with the USA and other partners), the Nimrod MR4 maritime reconnaissance aircraft and the Hawk jet trainer. The UK DIS announced that the UK does not expect to build a new generation of manned fast jet aircraft beyond the Typhoon and F-35 aircraft but it will need a through-life capability management for both these types.
- *Helicopters* are supplied by AgustaWestland which is owned by Finmeccanica (Italy).
- Rolls-Royce supplies engines for aircraft and helicopters (including collaborative programmes: Typhoon, F-35 and A400M airlifter, as well as for Nimrod MR4 and Hawk jet trainers). There are also UK-based suppliers of avionics and various parts, components and materials for aircraft and helicopters (e.g. Martin Baker ejector seats; Marshalls which undertakes modifications to UK Hercules aircraft). These firms represent part of the supply chain for UK military aircraft and helicopters.
- *Missiles* are supplied by MBDA which is a European monopoly supplier, jointly owned by BAE Systems, EADS and Finmeccanica. MBDA UK Ltd is the prime contractor for about half of the UK's in-service inventory of missiles. Other suppliers of missiles to the UK Armed Forces include Thales (France), BAE Systems Land Systems and Underwater Systems Ltd (torpedoes), LM (UK) Insys Ltd (USA) and Raytheon (USA).
- *Land systems.* The UK land systems industry is dominated by BAE Systems Land Systems which supplies AFVs, including main battle tanks and general munitions. Interestingly, the UK land systems industry has experienced major consolidation reducing the UK industry from some five prime contractors to one (Alvis; GKN; Vickers Defence; RO Defence; Marconi). UK contracts are not guaranteed to be awarded to BAE Systems: for example, on the Army's Future Rapid Effects System (a family of armoured vehicles), three foreign firms were invited to provide vehicles for trials with General Dynamics (UK) provisionally selected for the utility version. Firms in the supply chain include the William Cook Group, Caterpillar and David Brown (supplying tank track and transmissions). For general munitions, security of supply is important and BAE Systems was awarded a Framework Partnering Agreement (FPA) to supply 80% of the UK's repeat buys of existing general munitions. However, the FPA does not provide adequate incentives to BAE Systems to reduce its cost base and to provide services (DIS, 2005, p99). This is one published example of the problems of providing efficiency incentives to national monopoly suppliers. Whilst BAE Systems supplies 80% of general munitions, the remaining 20% is subject to a healthy competitive environment (92% of the remaining spend is with 12 suppliers, including Rheinmetall: DIS, 2005, p98).
- *The UK warship industry* provides a domestic capability in modern aircraft carriers, destroyers and frigates, mine patrol vessels, support ships and nuclear-powered submarines (attack and nuclear deterrent vessels). The major firms comprise BAE Systems with yards at Barrow and Glasgow, Vosper Thorneycroft (Portsmouth), Devonport Management and Babcock (Rosyth). The UK DIS committed the UK to retaining a nuclear submarine capability with deliveries of one vessel every 24 months. Similarly, the Strategy committed the UK to retaining a core workload of surface ship production in the UK involving one new platform every 1-2 years.

Where projects exceed the core work load, the UK reserves the right to use competition and potentially undertake work offshore: a development which promotes EDEM and EDTIB initiatives.

- *The UK defence electronics sector* embraces a variety of UK-owned and foreign firms, including BAE Systems, EADS Lockheed Martin, Raytheon, VT Communications, BT, QinetiQ, Fujitsu, Thales, General Dynamics, Northrop Grumman, Selex Communications, Ultra Electronics and EDS. There are SMEs at the sub-system level (Dowdall, Braddon and Hartley, 2004).
- Overall, the UK defence industry expects capacity reductions in fixed wing aircraft plants and in naval warship building yards.

Competent denoting especially the rapid exploitation of the best technologies. The UK defence industry has demonstrated such technological competence through its defence R&D spending and its involvement in a complete range of high technology air, land, sea and electronics systems. The UK defence industry is amongst the most technically advanced in the EU. It is also involved in collaborative programmes, especially with European nations (A400M airlifter; Typhoon; Meteor missile, as well as being a major development partner in the US F-35 aircraft). Two further features are worth highlighting:

- Where the UK buys major equipment from overseas it requires that the intellectual property rights and the design authority be based in the UK (e.g. FRES; F-35).
- The major UK defence firms, namely, BAE and Rolls-Royce, have links with UK universities. For example, BAE has University Partnership Programmes with the Universities of Cambridge, Cranfield, Loughborough and Southampton.

Competitive both within and outside Europe. The UK defence industry is a major exporter of defence equipment, especially of aerospace equipment (military aircraft and parts and missiles) to export markets in the Middle East, Asia, the Far East and NATO countries. Air systems dominate UK defence exports which is where the UK has a competitive advantage. For example, in 2007, air systems accounted for almost 80% of UK defence export orders (DASA, 2008). This sector has some world class firms such as BAE Systems and Rolls-Royce. However, the UK defence industry has been less successful in exporting land and sea systems, suggesting that it is not competitive in armoured fighting vehicles and warships. The UK warship industry exports only a small fraction of its output compared with France and Germany which in 2005 accounted for over 60% of the military warship export market. This reflects the world demand for modestly-priced frigates rather than the 'high-end complexity' represented by the majority of UK warship builders (DIS, 2005, p73). Nor is the UK competitive in submarines since it specialises in nuclear-powered vessels supplied to one customer and it does not produce conventional submarines (c.f. France and Germany).

UK d*efence industry supply chains*. SMEs are found in these supply chains, but there are major data problems in that little is known about UK defence industry supply chains (they are a black box). There is considerable knowledge of the major UK prime contractors and some of their first tier suppliers (e.g. BAE as a prime and Rolls-Royce as a first tier supplier to BAE). Supply chains are complex with a range of firms supplying inputs at various levels of the supply chain (e.g. first, second and third tiers, etc) and the chains vary between air, land and sea systems. Little is known about how important defence business is to suppliers, how large they are, where they are located, how important they are in local labour markets and most importantly, how transferable

are their human and physical capital resources (i.e. do the firm's labour and plant have alternative, non-defence uses?). Some suppliers, including SMEs are specialists with unique and distinctive expertise in a specific field. The complexity of defence industry supply chains is illustrated from one of the few UK studies in this area. This study of the Warrior Armoured Fighting Vehicle supply chain found (Hartley, *et al*, 1997):

- The prime contractor, namely GKN, had over 200 first level suppliers;
- At the first tier level, a total of 42 suppliers accounted for 85%-90% of the value of GKNs Warrior purchases;
- First level firms used an average of 18 suppliers; second level firms had an average of 7 suppliers; whilst third tier suppliers used an average of 2-3 suppliers. Typically, second and third tier suppliers did not know of their involvement in the Warrior programme (e.g. they supplied seals, gaskets and washers and they were not specialist defence companies).

Conclusion

The UK DIS makes some contribution to the development of the EDEM by recognising that in future, some of its defence equipment will be purchased from overseas. These areas of overseas purchase might also contribute to the development of an EDTIB[25].

The UK DIS faces some difficult choices:

- The Strategy is not costless. Retaining key UK defence industry capabilities involves a price: for the UK maritime industrial strategy, there was a total cost of £305 millions in 2007 (NAO, 2007).
- The absence of competition creates procurement challenges in providing efficiency incentives for monopoly suppliers. The MoD will need to address the issue of determining profitability and efficiency on non-competitive contracts. Effectively, MoD will need to regard UK monopoly suppliers as regulated firms. BAE Systems is the UK's major monopoly supplier of air, land and sea systems.
- Retaining capacity. Some defence industry capabilities are highly specialised and only capable of defence uses. Examples include main battle tanks, nuclear-powered submarines and stealth aircraft. The challenge facing the UK (and the EDA) is to devise cost-effective policies to retain such capabilities during troughs in development and production work. Possible solutions to retaining such capabilities include mid-life up-dates, small production orders and paying to retain key industrial skills. The problems of retaining capacity and the costs of the DIS will be accentuated by the current economic and financial crisis: supporting a UK national defence industrial base will be even more challenging.

The UK DIS vs the EDTIB strategy (EDA, 2007)

Key actions for governments to bring about EDTIB	UK situation
Clarifying priorities Which key technologies do we need and which industrial capabilities do we have and need	Appropriate operational sovereignty (operational independence; security of supply) • Responding to Urgent Operational Requirements • Through life capability management (with more

[25] Originally, the 2005 UK DIS was to be the first version which was to be revised in subsequent years. By February 2009, no further version of the 2005 DIS had been published.

	opportunities for military outsourcing) • Maintaining key and rapid industrial capabilities and skills • Maintaining intelligent customer-supplier relationships • The key defence industrial capabilities which will be retained in the UK include nuclear-powered submarines; core warship building; ammunition; and cryptography. These key capabilities are designed to achieve the aims listed under the bullets above.
Consolidating demand Effective national processes are required to ensure that the collaborative option is always considered in our procurement decisions.	Some defence industrial capabilities will not necessarily be retained in the UK with MoD reserving the option of buying from overseas. These sectors include large aircraft; trainer aircraft; helicopters; missiles; torpedoes; and where more than the core warship load is needed. These are areas where the EDEM can apply. They are also areas where the UK would accept an EDTIB capability to supply such products. Also, the UK has always been an active and major participant in European (and US) collaborative defence programmes. Mostly these have been in aerospace programmes (aircraft –eg Tornado; Typhoon; A400M airlifter; helicopters; missiles). On US collaborations, the UK has been involved in the UK-US Harrier and F-35 aircraft programmes: these also reflect the US-UK special relationship.
Increasing investments (spend more, spend better and spend more together on Defence R&T)	• Air systems is the largest spending sector. However, over the period 2006 to 2015, spending on fixed wing aircraft is expected to fall by almost 20% with obvious implications for reductions in production capacity in this sector of the UK aerospace industry. There are doubts about the future of two BAE aircraft plants, namely, Brough (Hawk trainer aircraft) and Woodford (Nimrod MR4). Closure of these two plants would leave BAE with two aircraft plants, namely, Warton and Samlesbury (both near Preston, Lancashire). However, there is expected to be a major increase in spending on helicopters (spending will more than double). Longer-term, there will be more spending on UAVs as these replace manned combat airctaft. • Land systems is the smallest spending sector: armies are relatively cheap on equipment. There is expected to be a substantial increase in spending on AFVs (with greater defence electronics inputs). • Spending on sea systems is expected to rise by some

	36%. This reflects planned orders for Type 45 Destroyers, Astute submarines and two new aircraft carriers. The end of this new build programme will result in a major reduction in demand which will create challenges in maintaining warship building capability in the UK: eventually, there are likely to be substantial reductions in capacity. Again, sea systems will be characterised by greater electronics inputs.
Ensuring Security of Supply Be confident that increased mutual dependence for supply of defence goods and services is matched by increased mutual assurance of that supply.	Retaining capacity. Some defence industry capabilities are highly specialised and only capable of defence uses. Examples include main battle tanks, nuclear-powered submarines and stealth aircraft. The challenge facing the UK (and the EDA) is to devise cost-effective policies to retain such capabilities during troughs in development and production work. Possible solutions to retaining such capabilities include mid-life up-dates, small production orders and paying to retain key industrial skills. The problems of retaining capacity and the costs of the DIS will be accentuated by the current economic and financial crisis: supporting a UK national defence industrial base will be even more challenging. The UK DIS aims to ensure security of supply in key technologies.
Increasing competition and cooperation Member States in general have relied on the "national security" exception in Article 296 of the Treaty establishing the European Community to make the bulk of their defence purchases on a national basis. This has had the effect of stunting the development of a proper European Defence Equipment Market – thus denying both the customer and the industry the benefits of competition, and hindering the necessary cross-border integration of the European DTIB.) • Cross-border transfers • Offsets • Equity amongst competitors Cooperation: achieving more, and more effective, collaboration	Some defence industrial capabilities will not necessarily be retained in the UK with MoD reserving the option of buying from overseas. These sectors include large aircraft; trainer aircraft; helicopters; missiles; torpedoes; and where more than the core warship load is needed. These are areas where the EDEM can apply. They are also areas where the UK would accept an EDTIB capability to supply such products. Retaining key UK defence industry capabilities involves a price: for the UK maritime industrial strategy, there was a total cost of £305 millions in 2007 (NAO, 2007). In effect, these areas are excluded from overseas competition and hence from the EDEM: they are Article 296 products. Also, these areas are the UKs Defence Industrial Base which will be retained within any future EDTIB. In other words, the UK has made some decisions about its DIB which are not negotiable within any future EDTIB: they form constraints on any future EDTIB but could be viewed as the UK's contribution to the future EDTIB. Overall, the UK DIS makes various contributions to the development of the EDEM and the EDTIB. On Offsets, the UK policy has applied offset requirements on defence equipment imports, usually from the USA. Examples of offset percentages have ranged between 100% and 140% (for Boeing AWACS). Such high offset percentages are misleading since they fail to focus on the net gains from offsets (ie the work which would not have been obtained without the offset – often

	offsets include work which would have been obtained without the offset). For example, on the UK buy of Boeing AWACS, the sale of Rolls-Royce civil aero-engines on Boeing airliners counted as part of the offset; but Rolls would have obtained this business anyhow without the offset. With imports and US-UK collaborations, there have been major concerns about technology transfer (eg F-35) with the UK requiring technology access as a condition of its involvement in such programmes (to ensure independence and security of supply). On competition, the UK DIS departs from competition policy and offers key firms guaranteed UK markets based on partnering agreements (effectively with national monopolies and the associated problems of determining prices, offering efficiency incenties and determining profits on non-competitive work). UK competition policy has never been concerned about equity: competition and equity are in conflict and competition has dominated until the UK DIS which departed from competition policy. On collaboration, the UK remains critical of the traditional work-sharing rules on collaborative projects (juste retour) and prefers to allocate work on the basis of competition.

C B Annex: Key technological change drivers

C.1 Increasing Intelligence

Driver description. For a very long time, intelligence was the sole property of human beings. With the advent of computer technology, the concept of Artificial Intelligence (AI) was introduced in the mid 1950s. John McCarthy, reputed to have been the first person who coined the term 'Artificial Intelligence' in 1956 defined it as "the science and engineering of making intelligent machines, especially intelligent computer programs" (McCarthy 2007)[26]. New software concepts, faster computers and greater memory storage are leading to increasingly better Artificial Intelligence with much improved capabilities in pattern recognition. Products are becoming increasingly intelligent owing to the integration of computer technology and network capabilities or by basing them on smart materials. "Things that think," as Neil Gershenfeld has put it, will become more widespread. Today a future like this does not look so far-fetched as it once did, as is demonstrated by e.g. RFID technology, smart cards, smart materials, increasingly smaller mobile computing devices and working concepts of ambient intelligence and ubiquitous computing. Artificial Intelligence and automated systems are also improving and semantic software is getting increasingly better. So-called graphical CAPTCHAs, short for Completely Automated Public Turing test to tell Computers and Humans Apart, which commonly consist of distorted images of numbers or letters are becoming increasingly challenging for humans to solve, whereas computerised pattern recognition gets increasingly better.

Factors of influence. The further development of Artificial Intelligence depends on the progress made in computer and processing technology. New advances in neurosciences and even biology may also contribute to improvements in AI, if biological systems and the human brain are considered as models for AI. But there has also already been expressed public concern about advanced AI, especially in view of the controllability of potential future systems.

Possible evolutions. The trend of improving AI is likely to continue as long as the computer processing power will grow, leading to ever smarter products. The next bullseye target of software developers lies in the creation of Artificial General Intelligence (or strong AI). The application of AI will lead to more autonomous products and the improvement of intelligence in humans and artefacts. Intelligence as a property of humans and objects (and maybe even hybrid entities of both) will be the central aspect of a future society and economy, and serve as a global enabler for finding solutions in a growingly complex world, driving further innovations.

Impact on the EDTIB: Intelligent technologies will be a key element for Europe's defence needs and accordingly R&D and industries will have to be strongly integrated into the EDTIB.

[26] http://www-formal.stanford.edu/jmc/whatisai/node1.html.

C.2 Robotisation

Driver description. Robots are now leaving the factory and entering public places and even our homes. They are becoming less expensive, smaller and more intelligent, versatile and even emotional. They come in different shapes and sizes for different purposes, to work in places ranging from outer space to the inner space of the human body. Japan and South Korea focus very much on humanoid robots (robots that have a human shape and human moving capabilities), and the US DARPA runs an annual challenge open to civilian participants to improve the capabilities of unmanned vehicles (DARPA Grand Challenge). Armed robot guards (although still without the capability to autonomously apply lethal force) are already among us, being deployed as border guards by South Korea, Israel, China and the US. In this sense, the impacts of robot technology have already aroused various issues of controversy. The South Korean government is in the progress of drafting a code of ethics to ensure human safety in the presence of robots, at the same time aiming to prevent robots and androids from being abused by humans. This is especially relevant because South Korea plans to put a robot in every household by 2020 (National Geographic Online 2007)[27]. Robots are becoming more humanlike/lifelike and intelligent (e.g. the South Korean android EveR), whereas humans, on the other hand, are about to fuse with their technologies on the other. In this sense robot technology and modern prosthetics are closely related.

Factors of influence. R&D for robotics is expensive and much depends on public funding for universities and research institutes, as well as the interest of the industry. Even Japan, where robot technology is generally viewed as an important strategic field for the industry (cf. Leis, 2006), has curtailed some robotics projects, e.g. Sony's 'QRIO' and 'AIBO' in times of financial problems. Progress in robot development also depends on AI and computer technology. It also stands to profit from insights developed in life sciences and neurotechnology.

Possible evolutions. If progress continues, robots will become more intelligent, versatile and cheaper and will be used for a growing number of applications. Current areas of emphasis, besides industrial applications, are entertainment, security, service, care for the elderly, medicine, space exploration and defence. If developments in AI, semantic technologies, pattern recognition, networking and mobility will eventually be combined, the robots of the future could become important assistants to humans.

Impact on the EDTIB. Although robot technology could be very useful for the nature of likely future defence operations, e.g. surveillance, detection of harmful materials, expeditions and demining, the development of sophisticated platforms promises to be expensive. Cooperation with Asian countries like South Korea or Japan may prove to be advantageous.

C.3 Ubiquitous Networks

Driver description. Central to the ubiquitous networks is the speed and vastness of modern communication technologies and platforms, most noticeable the internet. The main driver is the fast progress in the domain of computer and communications technology. The start of this modern development leads back to the 1970s, with the information technology revolution and the introduction of the first affordable personal

[27] http://news.nationalgeographic.com/news/2007/03/070316-robot-ethics.html.

computers. The introduction of the civilian internet in the 1990s gave a tremendous boost to the contemporary network society. All these oportunities greatly influence the way people work and will be working in the future. The diffusion of internet access and mobile communication is still growing, and the trend points towards ubiquitous networking. This does not only mean a quantitative growth in connectivity, but also a direction towards constant connectivity and information links between humans and technological devices. Network capabilities will have profound influences on future logistics, services, education, information supply and entertainment. Ubiquitous networks connect humans to each other as well as humans to (computer) technology. They will enable instant action and contact, instant global communication and increased information intensity. Research cooperations will span the entire globe with instant data exchange. Conferences will become virtual events and people will be able to work from any location.

Factors of influence. From the purely technological side, the further expansion towards ubiquitous networks will grow as long as resources and computer technology allow this. The advance of networking also raises increasing security concerns over privacy and data protection. In this sense, legal directives could be implemented that might slow down the further development of ubiquitous networking. Networks also necessitate standards, which will probably only be established once this issue arouses the interest of industries.

Possible evolutions. Our future society and economy will be more and more influenced by the next phases of the internet, transmission speed, networking technology and standardisation as well as ubiquitous computing and semantic internet technologies. The future of the network society is likely to include the fusing of the physical world and virtual realities (mixed reality, virtual overlays), ubiquitous computing and networking, location-based services and semantic web applications. An increasing number of common everyday objects (walls, clothing, glasses, etc.) may be fitted with capabilities to establish networks and store information. From a purely technological perspective there is still much room for further innovations to increase the capabilities of the network society for the next 15 years and beyond. From a social and political point of view, people or states can always decide not to continue this trend.

Impact on the EDTIB. Networking capabilities are central to the new defence strategies, but they are likely to require technologies that are custom-made for defence purposes. As far as security is concerned, ubiquitous networking is a double-edged sword, allowing faster information transfer and communication, but also posing the risk of information leaks and cybercrime (hacking, etc.). The information transported through networks is not material and issues of cross-border trade have to be seen differently if dealing with the digital transfer of data and information. The utilisation of ubiquitous network capabilities also necessitate the creation of standards that apply throughout all MS.

C.4 Miniaturisation

Driver description. Humans are able to see and modify ever smaller units of matter. Our ability to manipulate the most minute particles has already reached the scale of DNA fragments, molecules and even nanoparticles. Microelectromechanical systems (MEMS) are beginning to transform into nanoelectromechanical systems (NEMS).

Miniaturisation not only leads to faster computers and smaller devices, but also to materials with specialised and tailored properties (e.g. metamaterials) and new generations of sensors. Although much of this is still in the development phase, nano-based sensors (nanosensors) are expected to bring about revolutionary effects, allowing more accurate detection of increasingly smaller particles and miniscule amounts of substances. Their potential applications range from environmental protection (e.g. identifying polluting substances) over medicine to defence and security (e.g. detection of small amounts of chemicals or biological agents).

The new insights and capabilities in biology, ICT and molecular sciences have enabled the creation of smart and better materials that come with built-in intelligence, sensors and special properties, able to adapt towards their environment. A promising new R&D field deals with the development of self-assembling and self-repairing/self-healing materials as well as metamaterials whose structure has been modified in such a way that they even display properties that do not occur in nature (e.g. stealth to specific electromagnetic waves). Next generation computers based on nanotechnology, quantum mechanics or DNA will also rely on further possibilities in miniaturisation.

Factors of influence. The whole issue of miniaturisation is closely linked to ICT, (modern) nanotechnology and (modern) bio(techno)logy. Interestingly, the smaller the units to be analysed or manipulated, the larger the necessary equipment will be. Miniaturisation is still expensive. More efficient production methods have to be found to make applications like nanosensors or nanotubes affordable for commercial products.

Possible evolutions. If the methods of analysis and manipulation of small units of matter become more cost-effective, these technologies could have a profound impact on materials with specific and new properties, enabling innovative products for nearly any conceivable application. Safety concerns in regard to nanotechnology and possible regulations could, however, slow down the pace of progress in this area.

Impact on EDTIB. Currently, many techniques and applications of state-of-the-art miniaturisation are still expensive, requiring vast R&D expenses. In this domain, more cooperation will pay off financially. Concerns over possible implications of dual use in certain areas, e.g. specific nanotechnology applications, have to be carefully assessed and security measures need to be implemented.

C.5 Insight into How the Human Body Works

Driver description. Advances in biosciences, genetics and neuroscience combined with ICT and (modern) nanotechnology will contribute to an increasingly better understanding of how the human body works. This will very much contribute to understanding, curing and preventing diseases.

Advanced computer technology also plays an important role in this domain, especially in genetic, medical and neuroscientific analysis. In recent years, much progress has been made in genetics, neuroscience and neurotechnology. The speed of genetic sequencing has increased at an impossible rate, whereas the costs have dropped dramatically. Today, the sequencing of a whole human genome only takes 4 months (the sequencing of James Watson's genome in 2008), whereas the Human Genome Project, that started in 1990, needed over 10 years to accomplish the task. The 1000-Genome Project started in 2008, aiming to map the genomes of 1,000 people within the

next 3 years. The US genetics researcher and entrepreneur Craig Venter has announced a 500,000 US$ award to the first party able to sequence a complete genome for 1,000 US$. This could become reality soon, if one considers that the current commercial sequencing costs around 5,000 US$ per genome.

Progress is also being made in the area of neuroscience with the boldest project so far, the Blue Brain Project being pursued by the École Polytechnique Federale de Lausanne (EPFL) and IBM. Their ultimate aim is to produce a computer simulation of the human brain. They have started with mapping and simulating a neocortical column of a rat[28]. The results are thought to provide important insights for understanding forms of dementia. As a side effect new insights for improving AI technology are created, already fusing with the human brain. In an experiment conducted in 2004 rat neurons in a Petri dish were used to control a flight simulator (Discovery Channel Online 2004)[29]. So-called brain-computer interfaces have already become so sophisticated, safe and handy that the gaming industry is planning to release the first commercial BCI-based products in late 2008[30].

Factors of influence. Whereas scientific and technological advances will quite certainly contribute to further advances in research areas related to understanding the human body and brain, social resistance may grow. As the negative reactions towards stem cell research, genetics and advocates of so-called human enhancement technologies are growing, further progress in some related areas could become heavily criticised. The developments are quite new, and science is progressing fast, meaning that the direction of future reactions and legal implementations are currently hard to predict. However, this is one domain where social perception will be a major factor influencing future developments.

Possible evolutions. A better understanding of the human body and mind will lead to a better understanding of illnesses and even aging, and therefore contribute to improved medication and preventative measures. Epigenetics is an emerging research area that analyses the effects of external/environmental factors (e.g. nutrition, environmental pollution etc.) on gene expression. This concept is already influencing the food industry, which plans to make use of these insights to create healthier food. A better understanding of aging mechanisms could lead to medications and procedures to counter age-related diseases. In face of the expected problems related to the aging society, this research area receives increasing attention. A controversial side effect that may arise out of the better understanding of the human body and mind are so-called human enhancement technologies (HET), i.e. science-based technologies for improving human mental and physical capabilities designed to exceed functions defined as normal. These ideas were brushed aside as science fiction a decade ago, and right now they have already advanced to the extent that policy-makers at national and EU levels are discussing them.

Impact on the EDTIB. This is a highly interdisciplinary area with an interesting potential for defence (cf. Annex D on Soldier Modernisation) in regard to protection, medicine and improvement of efficiency. Human factors research is also a related domain that is receiving increasing attention from defence, dealing e.g. with insight into human process information and responses towards external stimuli and situations.

[28] http://bluebrain.epfl.ch/.
[29] http://dsc.discovery.com/news/briefs/20041018/brain.html.
[30] http://www.neurosky.com/menu/main/technology/product_summary/.

Neurosciences play an important role. For the EDTIB this means that closer R&D cooperation may be necessary to accomplish substantial progress. But also here dual-use concerns could be relevant, especially since much of the civilian research and technologies in this domain are subjected to severe criticism.

C.6 Virtual Modelling and Testing

Driver description. In all domains virtual modelling and testing are becoming more sophisticated and widely applied. Applications are found in traffic management, evacuation planning, archaeology, testing of components and (engineering) designs, ecology, medicine and even drug discovery. Virtual modelling and testing can have great advantages for cost reduction (no real material is destroyed in the tests), speed up development time (e.g. in the pharmaceutical industry) and promote animal protection (e.g. by partly substituting for animal testing). Improved computer soft- and hardware as well as advances in mathematical and computational sciences will lead to further optimisations and new applications of virtual modelling and testing.

Virtual reality is already an integral part of gaming and online entertainment, delivering essential inputs for training technologies. Simulations are becoming more realistic and practical applications more sophisticated. The Japanese Earth Simulator is a huge supercomputer facility able to run complex simulations on the global climate by taking into account oceans and the atmosphere. In 2008 the announcement was made that the Japanese will build a second system. A similar large simulation project is the Blue Brain Project, already mentioned above. Other simulations deal with protein folding, complex aerodynamics and simulations for drug discovery and testing (in silico testing).

Factors of influence. The support for simulation technologies is generally high, because it reduces risks and enables research that could not be done otherwise (e.g. climate simulations). Advances in computer technologies, mathematics and an increasing the amount of types for creating simulations and computer-based modelling are likely to lead to further advances, thus increasing the number of possible applications.

Possible evolutions. Simulations will most probably become more realistic and accurate, meaning that increasingly complex phenomena may be simulated. Simulation technology is also scalable from rather inexpensive implementations with an emphasis on visual components for entertainment to highly expensive projects necessitating state-of-the-art supercomputers. Simulations are likely to become an integral part of entertainment as well as research and development.

Impact on the EDTIB. For the military, important applications lie in training and operations planning. Simulations are being used in all areas of military training, ranging from flight simulations over virtual boot camps to psychological preparation. As far as virtual reality and training are concerned, civilian developments from the gaming industry increasingly find their way to military use. Virtual testing, modelling and simulations are also applied in operations planning, where different strategies and scenarios can be run in preparation for possible assignments within a safe environment. This also leads to improved impact assessment and the minimisation of losses as well as improved safety and cost reduction. Industries (e.g. the gaming industry, providers of e-learning systems) and research institutes that deliver the necessary know-how and

technologies are likely to become part of the EDTIB. In this area the dual-use concerns are likely to be much less crucial than with other technologies.

C.7 Better Understanding of Society

Driver description. The importance of social sciences and social and cultural studies is growing, especially in relation to science and technological development. It is assumed that the pace of scientific and technological progress will continue to increase within the foreseeable future. Societies and decision-makers will therefore have a hard time to catch up with all the relevant developments. Cultural diversity and the number of personal life choices will also grow, necessitating a better understanding of how society works. The latest developments combine computer sciences with social sciences to create improved AI or simulate human reactions and behaviour.

Disciplines such as socionics, combining sociology with computer sciences and simulations, are also receiving more attention. They provide useful inputs for traffic management, architecture (e.g. for emergency exits, avoiding trampling accidents in stations) and even public health to assess the impact of pandemics.

Factors of influence. Classical social scientists are generally rather sceptical about technology and natural sciences, a trend that could lead to unfavourable effects on scientific and technological progress. But they could also contribute to the development of safer technologies if applied in a constructive way.

Possible evolutions. It is very likely that societal aspects will be increasingly considered in nearly all areas of human decisions. ELSI/ELSA (ethical, legal, social implications or aspects) are already an integral part of assessing new technologies and scientific trajectories. The importance of considering societal factors will even increase as risk perception will grow, since contemporary risks are regarded as mostly man-made, possibly having huge impacts on the future of humanity.

Impact on the EDTIB. The understanding of societies and different cultures is an important contribution to what is defined as defence priorities by most MoDs in MS. Conflict prevention and effective reconstruction have become increasingly important for the military. The objective of military involvement of (most) democracies lies not in territorial gains, but in accomplishing societal and political changes. Armies are also involved in the reconstruction of the social, political and economic settings where conflicts have occurred. Therefore the social and cultural understanding becomes increasingly important for conflict prevention as well as reconstruction.

Also for strategic planning, not only technological aspects but also social and psychological factors are very important. Especially the omnipresent media coverage of military interventions plays an important role. This always has a huge impact on popular support for military missions.

The focus on ethical, legal and societal aspects (ELSA) and technology assessment renders military technologies a central topic that is often viewed with a degree of criticism.

A better insight into socio-cultural issues also plays a crucial role if the cooperation between European MS increases. In general, the growing focus on social issues serves

as a driver for improved cooperation, more security and greater acceptance of military operations.

Although this is not a technology in itself, experts will be required to use technologies like surveillance or simulations in the appropriate way.

C.8 Better Understanding of Ecosystems

Driver description. Environmental responsibility has become an important topic. The search for more ecologically friendly technologies is already a major driver for innovations, ranging from cars and energy supply to server farms and improved manufacturing processes.

This is not just about protecting nature, but also about the management of important resources for humanity. Only recently, people have initiated more systematic analytical approaches towards highly complex systems like ecology or weather patterns. Computer technology plays a central role. Without it complex calculations and simulations would be impossible. Also, the growing interest in oceanic science is a rather recent phenomenon. Although oceans harbour most of life on earth, being an important factor reigning the climate and ecosystems, merely 1% of them are explored. A better understanding of ecosystems also provides an improved understanding of complex systems and may even contribute to networking and swarm intelligence.

Factors of influence. Environmental sciences and research on ecosystems are regarded as essential to understand the climate change and sustainability. Efforts in this direction will receive much support.

Possible evolutions. Ecosystems are very complex and it is questionable if a real understanding can be achieved. But the strong support for such efforts will generally lead to improved efficiency of energy and material use and will provide impulses for further development in the area of simulations and oceanic exploration.

Impact on the EDTIB. This aspect may have a different focus in civilian or military contexts. In the military context, the understanding of ecosystems is predominantly related to understanding the terrain, flora and fauna, the conditions in specific climate zones and their advantages or disadvantages for manoeuvres or combat strategies. Energy-efficiency not only has positive effects on the environment, but it also improves the capabilities for defence operations.

It is highly desirable that military activities leave as few traces behind in nature and ecosystems as possible. Munitions containing groundwater-polluting substances and land mines that limit the available arable land are some of the pressing problems. Military environmental protection has already been integrated in the military code of conduct of operations in some countries, including the US and European countries. In this sense, environmental aspects will become an important issue for industries within the EDTIB.

C.9 More Efficient Manufacturing

Driver description. More efficient product manufacture is economically and ecologically important. Less use of energy and material will save costs and protect the

environment. Since many materials do not last forever, ways have to be found for doing more with less. Also, government and international regulations call for more efficiency in industrial production. This trend opens a new dimension for renewal and innovation, leading to new technological solutions and practices substituting outdated methods. Combined heat and power, a reorganisation of processing steps, improved insulation and reduction of vibration in machinery as well as recycling and improved logistics are but a few examples. A better understanding of ecosystems also leads to innovative manufacturing processes like cradle-to-cradle, where materials used in industrial processes are viewed as nutrients integrated in a cycle similar to natural life cycles.

Factors of influence. Since most resources are finite, more efficient ways in manufacturing are necessary to keep them available as long as possible. Financial, legal and socio-political pressures will push manufacturing towards more efficiency.

Possible evolutions. If no significant efficiency will be achieved, essential raw materials will become increasingly scarce, leading to higher prices or even depletion. Scarcity of materials and energy will have profound negative effects on technological progress and social stability. Future conflicts and wars may arise over energy and raw materials and their property rights.

Impact on the EDTIB. As many important materials used in high-tech products are finite, more efficient manufacturing is important in the civilian as well as the military domain. Energy-efficiency is a topic that is regarded as highly essential throughout Europe and across the industries. For manufacturers of military equipment, sustainability issues will start to play an increasing role, including public pressure, but mostly also when it comes to saving material and production costs. Efficient manufacture may also become an important factor when selecting suppliers.

C.10 Convergence of Science and Technologies

Driver description. As science and technology advance, so does the realisation that the various disciplines are actually related to each other. For example, research in Artificial Intelligence is closely related to neuroscience, microchip technology is entering the domain of nanotechnology and even the borders between biology (self-assembling structures) and technology are becoming opaque. Bionics or biomimicry is a prominent example for the cross-fertilisation of biology and technology. The design of some modern ships and airplanes is inspired by birds and aquatic animals to reduce drag and prosthesis. Robots are becoming more lifelike. This development is leading to a convergence of science and technologies which ideally will lead to an improved cooperation between different research areas in natural sciences, engineering, social sciences and humanities in order to find better solutions in a world that grows increasingly complex and interconnected. Therefore, the convergence of science and technologies is not only restricted to the convergence of nano-, bio-, information, and cognotechnologies (abbreviated to NBIC convergence), but also includes other natural sciences like geosciences, social sciences, humanities and ethics. An inter- or transdisciplinary approach could mean an important paradigm shift in scientific practice. The industry welcomes this idea, but not so many universities.

Factors of influence. The convergence of science and technologies, especially in regard to the NBIC convergence and emerging technologies has led to great controversy, the scenarios ranging from ‘paradise engineering’ to ‘global destruction’.

The final truth will probably be found somewhere in the middle. Already the debate about these and other issues is becoming more rational and pragmatic. Ethical, legal and social aspects and perceptions play an important role in the perception and definition of 'convergence'.

Possible evolutions. Converging technologies, as the envisaged convergence of NBIC sciences and technologies is commonly called, is a much discussed driver for advanced and potentially disruptive and far-reaching civilian as well as military technologies. Possible developments may include advanced Artificial Intelligence/Artificial General Intelligence, advanced nano- and biotechnology, improved environmental technologies, new forms of medication and medical treatment, and even cognitive and physical enhancement and improved forms of biomedical engineering (e.g. artificial organs and tissue engineering). Inter- and transdisciplinary research is generally very much advocated and the integration of social sciences and ethics is regarded as a balancing factor and control mechanism for scientific and technological development. The development of and necessity for closer cooperation between different disciplines seems to be inevitable as science becomes more complex and interrelations occur more often.

Impact on the EDTIB. Interdisciplinary approaches are also necessary for successful defence operations, especially in the envisaged new types of operations and key objectives. The EDTIB should therefore be highly interdisciplinary and deliver a wide range of expertise, and capabilities that facilitates any combination in a successful and complementary manner. It is likely that different MS will possess different specialities and thus make cooperation a rewarding practice.

D Annex: Trends in innovation

D.1 Soldier modernisation

Description. The various soldier modernisation programmes worldwide all stem from the need to improve the survivability and effectiveness of individual soldiers in combat. This includes an extremely wide range, from improved training, protective clothing and advanced body armour to networking capabilities and advanced medical procedures. Throughout military history, there have been constant improvements in all these domains, but the modern trends in science and technology (S&T) open up new opportunities.

Advances in computer technology, ICT and Artificial Intelligence (AI), satellite technology and networking allow improved information gathering and sharing, better coordination of missions and computer-aided support for orientation, intelligence and communication. The Networked Soldier is a future concept that is followed by most modern armies around the world. S/he will be linked to other personnel, command posts, equipment, GPS systems, the internet and medical stations. Helmet-mounted displays, augmented reality, cameras, personal location systems and spatial orientation assistance, real-time translation systems and uplinks to the internet and medical surveillance will become part and parcel of the modern soldier information and networking equipment.

Personal protection and rapid medical attention is vital for survivability. As ballistics advance, body armour has to improve with it. Advances in material sciences (e.g. nanotechnology) play an important role, enabling highly protective (even against BC agents) still lightweight and flexible materials for uniforms. The latest developments include the integration of 'intelligent fluids' (magnetorheological fluids) into uniforms that can transform from liquid to a solid state in a matter of milliseconds through electric current. Once sensors detect a ballistic threat, the change of aggregate state will be triggered automatically.

In addition functions like, self-repair, thermal control, colour changes (halocromatic materials providing adaptable camouflage), sensor systems, night vision, health monitoring devices and even water recycling units and medical treatment systems may be integrated into future uniforms. The necessary S&T are within a proof-of-concept phase.

There is one other research domain that does not deal with uniforms and equipment, but with improving the capabilities of soldiers themselves. A better understanding of the human body can lead to the development of better nutrition and medication, as well as enable technologies and techniques that can modify and improve human physical and cognitive properties. Although cyborg warriors or genetically or nanotech-modified soldiers are still science fiction, related research programmes have been proposed in the US. Topics include substances and procedures to block pain, reduce fatigue, improve strength, cognition and duration.

Factors of influence. Soldier modernisation heavily depends on advances in a wide range of scientific disciplines, including material science, AI, ICT and bio(techno)logy. Fast progress is being made in all areas in civilian and military contexts. The further pace of development is not so much a question of technological possibilities, but more one of public perception and the legal and political framework.

Possible evolutions. The general ideas for soldier modernisation are sometimes far-reaching. The US seems to act – as always – in a much bolder manner than Europe, at least if one relies on open source information. Improved protection, networking and ICT assistance, i.e. advancement of personal equipment, will quite certainly become more widely applied during operations. Other forms of modernisation mentioned above are not likely to be applied within the European context in the foreseeable future.

Impact on the EDTIB. Since this is an area where innovations can come from different research fields and disciplines, more openness of the EDTIB would be of advantage especially in regard to better and more cooperative R&D spending.

D.2 Armoured fighting vehicles

Description. An important property of armoured fighting vehicles is their robustness and ability to negotiate rough terrain. The next generation (land) fighting vehicles should be superior in protection, versatility, speed and range. In the past, improvements in armour often came with trade-offs in mobility and fuel efficiency and/or range, but advances in new materials such as composites and nano-based materials allow improved armour while at the same time achieving weight reduction. For many classes of military vehicles, weight reduction means better manoeuvrability and fuel efficiency. This, in turn means extended ranges and less cost. Stealth and camouflage are also important properties. In this domain modern material science already provides innovative concepts.

Factors of influence. Many developments like robust lightweight materials and fuel cell technology that create an advantage for defence are also interesting for civilian applications. Civilian innovations could therefore deliver important inputs. Technological developments in many areas, such as materials and sensor/detection systems, can lead to innovative protective measures for armoured fighting vehicles and improve their speed, manoeuvrability and range.

Possible evolutions. Armoured land vehicles will remain a vital part of defence equipment, since most operations will take place on land. They are also important for supply and logistics. As anti-tank technology (e.g. anti-tank guided missiles / ATGM) is improving, protective measures have to advance as well. Active protection systems (APS), for example, prevent the missile from hitting the vehicle in the first place by either destroying a missile or confusing its guidance system.

Impact on the EDTIB. Advances in this area require more intensive R&D and will increase equipment costs. An EDTIB can help to improve R&D efforts and reduce costs through joint cooperation efforts.

D.3 High-performance aircraft

Description. Fixed-wing aircraft (and helicopters) form a ubiquitous element in defence. Because of their high speed (often supersonic) and the necessity to perform complex in-air manoeuvres, the requirements for materials and safety are very high. Aircraft also need to be protected from attacks. This can be achieved through stealth technology, making them undetectable to radar systems. However, stealth planes are very expensive. A general distinction is made between combat and non-combat aircraft.

The latter are not designed for combat operations and are mostly used for the transport of troops and materiel.

Innovation in military jets draws heavily on innovations being made in material development, ICT and communications technology. The tasks for fighter pilots are also becoming increasingly demanding. Ergonomic displays and pilot augmentation systems have become indispensable in the modern cockpit. Head-up displays, for example, project all important flight data onto the front glass panel of the cockpit or the helmet visor, so that the pilot will not be distracted by looking down at his instruments. The development of improved displays and augmentation devices is not just a matter of technology, but also of psychology and insights into the way human perception works. In modern combat aircraft, an ultraquick response is an ability any pilot has to master.

Aircraft speed highly depends on the design of engines and propulsion systems, as well as on on the ergonomics of the body design. For the latter, the latest inspirations may come from biology, where the emerging area of bionics as the science of applying designs of nature to engineering problems could play an important role.

Factors of influence. Aircraft will remain a very costly part of defence. The general technologies for aircraft innovations in defence are available, but budgetary restraints will decide in how far these can be applied and in how far joint cooperation in development and procurement will go. The Eurofighter Typhoon is an example of joint cooperations between different countries and firms. It is also being exported to non-European countries (e.g. Saudi Arabia).

Possible evolutions. In November 2008, 12 EU governments (Belgium, the Czech Republic, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Portugal, Romania, Slovakia and Spain) decided to launch the European Air Transport Fleet (EATF), a project to create a joint fleet of transport aircraft to cope with the logistics problems for defence and humanitarian operations. The project is planned to be fully operational in 2014. It is designed to improve the current problematic situation of European airlift capacity and make Europe less dependent on the US.

Impact on the EDTIB. The EATF points into a positive direction towards a strong EDTIB and demonstrates that cooperative developments can also arise out of simple necessity.

D.4 High-performance special-purpose ships

Description. There are many types of naval vessels, ranging from speedboats to aircraft carriers and submarines. They can also be used for different purposes like patrolling, the transport of troops and equipment, mine-sweeping, combat and medical service (hospital ships).
In some respects, similar aspects apply to ships as they do to aircraft. This is especially the case with materials, stealth properties and design. Design is crucial for ships, since at a certain point the shape acquires greater influence on additional speed gains than additional propulsion power. However, propulsion systems and engines nonetheless form an important element, albeit that besides power, noise and fuel reduction also start to play a greater role.
Communication systems and ergonomic displays are essential on naval vessels. Similar to the development of such systems in aircrafts, human factors research and insights

into human information processing and perception are important inputs for further optimisation.

Factors of influence. Ships likewise belong to a costly segment of defence, especially if the demands for advanced equipment grow. Piracy has become a growing problem that is threatening international trade (routes) and passenger ships. One of Europe's missions lies in patrolling and the protection of civilian ships against pirates.

Possible evolutions. In 2008 a European Union naval taskforce, consisting of 6 warships from 8 EU countries was established to patrol the Indian Ocean and Gulf of Aden to provide protection from piracy. However, the number of ships is still insufficient to provide adequate protection.

Impact on EDTIB. The EU naval taskforce may have similar effects as the EATF, leading to more cooperation in operations, and, by extension, to increased technological development.

D.5 Unmanned platforms and robotics

Description. Military robotics form an S&T area that becomes more and more important. Unmanned vehicles may be deployed anywhere, in the air, on land, above or under water and in outer space, typically in circumstances too 'dangerous, dull or dirty' for humans. Whereas (remote-controlled) unmanned drones are already quite common, a growing focus is presently geared towards autonomous vehicles. Now that Artificial Intelligence is improving, autonomous robots are becoming more suitable for military deployment. Especially the US Defense Advanced Research Projects Agency DARPA is fostering this development through the DARPA Grand Challenge competition that challenges research institutes, companies as well as individual players to come up with the best solution for getting a vehicle autonomously from A to B through difficult terrain.

Currently, unmanned platforms are mostly used for surveillance. But there are also robots that can be armed with sharp munitions and are, at least in theory, able to act on their own. Due to legal considerations, however, there is still a human in the loop for control. But there are already legal and ethical discussions about the actual role and necessity of the humans in the loop.

Factors of influence. Unmanned platforms and drones certainly have their advantages and as technological advances in ICT, sensors, AI and related disciplines will increase, the use of automatic and robotic equipment is likely to become much more prominent in defence. This is also an area where cooperation between civilian and defence actors can be advantageous. Some robotic platforms developed for civilian usage (e.g. for surveillance or police forces) could also be deployed in the context of defence and even equipped with weapon systems. However, public perception will play an important role in the acceptance of robotic systems, especially for defence purposes.

Possible evolutions. If advances in AI, semantic technology, pattern recognition and sensors will further increase as predicted by many experts, robotic defence systems will become more versatile, autonomous and intelligent. The development of robotic systems is also closely related to the development of the abovementioned intelligent

expert systems and networking technology. The development of autonomous vehicles, for example, is constantly improving and military robots have already been developed.

More far-fetched ideas come from DARPA, including the proposal of mind-controlled battle robots. In 2004 researchers from the University of Florida apparently succeeded in using an array of rat brain cells to control a fighter jet in a simulator. Current progresses in BCI (Brain Computer Interface) research and practical applications serve as proof of concept that such ideas are possible. In principle, that is.

Impact on the EDTIB. In general, unmanned systems contribute to the safety of human personnel and are very useful in surveillance operations. Unmanned systems will become more important for defence, but their development is associated with high-intensity R&D and high cost. For this reason, the domain of unmanned systems should remain in the focus of the EDTIB.

D.6 Precision weapons

Description. Precision (guided) weapons and munition should hit the designated target with high accuracy, while minimising collateral damage. This requires guidance systems by radio control, IR, laser, satellite or other forms of electromagnetic-based systems. Hybrid systems, combining laser with GPS belong to the latest developments. The third generation of targeted missiles is called 'fire-and-forget', since these missiles should be able to find their target autonomously after being launched. The target's properties are generally preprogrammed and special sensors, accelerometers, gyroscopes, GPS and optical technologies are integrated into the missile itself. Current developments are aimed at improving the precision also for smaller targets.

Factors of influence. Growing criticism of collateral damage will call for more precise weapons systems that focus on the military target only. Precision weapons increase the probability of hitting the right target, but they can make systems and operations more complex and expensive. On the other hand, the avoidance of collateral damage and civilian casualties may contribute to a greater support of defence activities. Legal requirements and ethical considerations will increase the trend for developing more precise weapons systems.

Possible evolutions. Precision weapons will improve as enabling technologies like GPS and other guidance and target systems also improve. Social and legal pressure also contributes much to the efforts for their further development.

Impact on the EDTIB. Improved precision will be an element that is important to all weapons systems. Boeing has developed a guidance system that provides GPS and laser guidance in one package at a comparatively low price.

D.7 Beyond Visual Range weapons

Description. BVR weapons have the advantage of being the first to shoot and hit the opponent's installations. Systems for target detection, target tracking and (in case of missiles) propulsion are central elements to BVR weapons. The guidance system is commonly provided by radar and/or infrared and/or laser. The latest developments are the fire-and-forget systems that have been already referred to above. Optical technologies, navigation and ICT are the important technological drivers. The

Eurofighter was developed for optimised BVR air combat. Long-range strikes will be especially important to compensate for an opponent's quantitative advantage.

Factors of influence The development of BVR technology is closely related to precision (guided) weapons technology.

Possible evolutions. The further development of BVR weapons also calls for new stealth technology rendering equipment undetectable to radar or other sensor technologies. Developments in metamaterials could enable entirely new kinds of stealth technologies. Current prototypes already render objects undetectable to microwave and far infrared radiation. Progress is also being made to achieve similar results within the electromagnetic spectrum closer to the visual range.

Impact on the EDTIB. BVR improves the own safety, but also makes the own troops and equipment more vulnerable to enemy BVR technology. Superior BVR capability therefore provides the necessary operational and tactical advantages. This requires fast innovations that will be better accomplished through joint R&D initiatives.

D.8 Nuclear, Biological and Chemical defence

Description. NBC weapons are weapons of mass destruction. During the Cold War, much attention was paid to nuclear defence, whereas current developments focus on biological warfare. Advances in biotechnology lead to improved defence systems (e.g. bionic sensors) but also to more lethal and hard-to-detect weapons.

High-precision thermoflux weapons that generate very high temperatures for longer periods of time can destroy chemical and biological weapons. Other defences include protective clothing and shelter, decontamination procedures and medical treatment or even immunisation. Here material sciences and biosciences play an important role. The focus on chemical and biological defence is also of interest to civilians and reflects the latest developments in terrorism.

Factors of influence. Growing concerns over terrorism may shift attention towards the C (chemical) and B (biological), whereas the nuclear threat is still clear and present (e.g. possibly Iran, North Korea). Preparation for chemical and biological defence, however, necessitates other forms of technologies like sensors, protective gear or specific medical treatments or immunisation.

Possible evolutions. It cannot be ruled out that rogue parties get hold of potentially lethal chemical and biological material. General advances in bio(techno)logical knowledge and genetic engineering do contribute to such scenarios. Especially biological agents may be relatively cheap to produce (they have the capability of self-replication), are easy to conceal and hard to detect. Costs for protection are likely to exceed the costs of attacks. Since NBC protection also affects the civilian populations, this issue has a high priority for defence.

Impact on EDTIB. The development of countermeasures against NBC weapons is expensive and requires extended expert know-how. Therefore joint R&D efforts are necessary. In the context of biological weapons (and possible future advanced nanotechnology) the issue of dual-use science and technology (transfer) has aroused

much controversy. Biological weapons and biological countermeasures are closely related. Appropriate security and control measures have to be established.

D.9 Non-lethal weapons / less lethal weapons

Description. A wide range of non-lethal weapons is under development, also for use against civilians, e.g. for the police, riot control and even personal self-defence. As defence forces are also increasingly deployed in reconstruction efforts, peacekeeping and humanitarian aid, non-lethal weapons may become necessary for self-protection in civilian environments. Non-lethal weapons are not intended to kill, but they do have the capability to disable people, e.g. cause blindness through laser radiation. Electroshock weapons (e.g. taser) do bring about some controversy, because they can have lethal effects in some cases. Active Denial Systems (ADS) are microwave-based weapons that can operate within an approx. 500 metre range and lead to a temporary burning sensation on the skin. They are currently going through testing. These weapons should prevent people from entering restricted areas.

Factors of influence. The interest in non-lethal (or less lethal) weapons primarily originates from outside the military, especially the police and civil security forces. The development of non-/less lethal weapons can build on a variety of scientific insights and technologies ranging from paralysing biological and chemical substances to energy weapons. A shift from combat missions to humanitarian and reconstruction operations has turned non-/less lethal weapons into an interesting option for military defence. Non-/less lethal weapons are becoming increasingly widespread in civilian use and can even be bought off-the-shelf. Non-lethal weapons may cause permanent harm or even death; hence the alternative use of the term ‘less lethal weapons’.

Possible evolutions. The development of less lethal weapons will progress further, since technologies advance and more applications and customers will be found. This will especially be the case when their safety will improve and side effects and lethality decrease. The general support for developing and improving non-/less lethal weapons receives more support and funding – also in the civilian context – than R&D for lethal weapons. Further development may even have an impact on future warfare.

Impact on the EDTIB. Various civilian developments already exist in this area. COTS and MOTS procurement strategies seem to be quite efficient in this domain.

D.10 Directed energy weapons

Description. In energy weapons electromagnetic radiation is used instead of a kinetic or explosive energy as the means for destruction. Lasers, masers, particle beams, electromagnetic pulses and sonic weapons all belong to this category. Especially electromagnetic wave-based weapons (lasers) are superior in speed (speed of light) and therefore provide some real tactical advantages. However, the current systems are expensive and require rather fragile mirror systems.

Another type of weapon that receives ample interest is plasma-based weaponry. These weapons use ionised gas or plasma created by lasers. The development is still in its early phase and there currently seems to exist just one prototype in Russia. At present, most other types of energy weapons are not advanced enough for practical applications.

One other energy weapon type that needs to be mentioned is the electromagnetic (pulse) bomb or e-bomb. It emits a strong electromagnetic pulse that disables all electronic devices like computers, transistors and motors and could therefore lead to extended civilian harm, even if it does not kill directly. The current state of development of such weapons cannot be reliably verified through public sources, but their effects could be devastating.

Factors of influence. Directed energy weapons form an emerging domain that includes a potentially wide range of applications.

Possible evolutions. Although the general interest is quite high, R&D are quite expensive. Directed energy weapons are very likely to see further development and they will be used in the future, albeit probably not on a large scale in the short and medium term.

Impact on the EDTIB. If the technology becomes mature and affordable, this could have a severe impact. Europe has some catching up to do with the US.

D.11 E-learning and simulations

Description. Training is a crucial aspect when it comes to preparing personnel for defence operations. In a fast world, learning and training have to be flexible. E-learning courses are suitable for just-in-time learning, i.e. delivering necessary knowledge and preparation when it is needed. Global networking and information sharing and access make just-in-time learning and education increasingly easier. Since e-learning is widespread in non-defence usage, civilian technologies and concepts can be an important source for military use. (Potential) military e-learning curricula may include subjects like languages, social competences and socio-cultural courses.

A very important trend in military training is the broad use of simulations. In all areas, civilian and military, virtual modelling and testing are becoming more sophisticated and more widely applied. For the military, important applications lie in training and operations planning. An interesting new application area might be dealing with post-traumatic stress situations. Simulations are being used in all areas of military training, ranging from strategy and scenario testing, flight simulations and virtual boot camps to psychological preparation. The great advantage of simulations lies in the existence of a realistic but safe environment. The civilian gaming industry plays an important role in the developments for military use.

Advances in different areas of virtual reality, virtual modelling, testing and necessary computer capacities as well as computational and mathematical insights are crucial to the further development of military training, operations planning, strategy and safety and security, but also for the development of advanced military technologies like aircraft or weapons systems.

Factors of influence. E-learning requires more individual motivation and feedback control. Also, the curricula must be constantly updated.

Possible evolutions. The use of e-learning and simulations will become more widespread, since the technologies and didactic methods are improving. However, one must avoid a situation where e-learning and just-in-time learning only produce superficial knowledge and inhibit creative thinking. Since simulations are becoming increasingly realistic and versatile, offering training opportunities within a safe

environment, they are very likely to be introduced in a wide array of areas. Still, even the most realistic simulation can never replace reality.

Impact on the EDTIB. Good defence training is vital. The EDTIB should ensure that the necessary equipment is provided to the MS and equally high standards are maintained. Civilian technology is very advanced in these areas and, accordingly, civilian technology-based firms may become part of the EDTIB.

D.12 Military information expert systems

Description. An information advantage is crucial to military success. As the amount of information increases and communication becomes faster, humans increasingly have to rely on computer systems to help them retrieve and filter information, as well as to support decision-making.

Expert systems are computer programmes that reproduce the services and performance of human experts. Decision Support Systems (DSS) help decision-makers in drafting their decisions. Expert systems and decision-making systems have been around for more than two decades. Their advantage is providing logical and consistent answers. However, they still lack human common sense. This deficit may be partly overcome through advances in semantic software and Artificial Intelligence. The interest in expert systems is huge, also in the civilian domain.

The internet and wireless communication make access to expert systems faster and more ubiquitous. Network technologies improve the sharing and collective assessment of information, thus improving the cooperation between man and technology, including military ICT networks, network-based information management and integrated combat management systems.

Especially the tempo of combat and the importance of preparation and intelligence call for technological assistance in friend-foe identification, early-warning systems (e.g. through networked sensor arrays), hazard management and real-time battle damage and strategy assessment.

Factors of influence. Improvements in AI, pattern recognition and semantic technologies will provide the largest impulses for further developments.

Possible evolutions. Information expert systems, simulations and e-learning concepts could fuse with each other. Geodata and sensor information fed into these systems may then enable real-time analysis. Intelligence expert systems will become more important, more information will be gathered in digital formats. These systems will assist in the identification of radar images, sensor data and surveillance information. Expert systems, coupled to simulation technologies can also assist personnel in assessing potential threats, tactical alternatives or the impact of specific actions.

Impact on EDTIB. Technologies for intelligent expert systems will be an integral part of modern defence equipment, but the areas of application may differ. Although the basis of expert system technology is also used in the civilian domain, the requirements for defence are substantially different.

D.13 Information operations

Description. Information is a vital military resource. This not only applies to military intelligence, data analysis and networked equipment and personnel, but also to media influences on the public. Information is a vital asset, but also a target: hence the importance of so-called Information Operations (IO), identified as "[…] the integrated employment of electronic warfare (EW), computer network operations (CNO), psychological operations (PSYOP), military deception (MILDEC), and operations security (OPSEC), in concert with specified supporting and related capabilities, to influence, disrupt, corrupt, or usurp adversarial human and automated decision making while protecting our own" (Joint Chiefs of Staff, 2006).

From the technological side IO relies on options for dealing, among others, with electronic attacks, electronic protection and electronic support, but also with solutions to identify distorted information, or to analyse or manipulate information.

Factors of influence. Advances in information and networking solutions and technologies play a central role in improving Information Operations.

Possible evolutions. Cyberattacks and cyberdefence, electronic surveillance as well as cyberespionage are very likely to increase, and so does the use of media as a 'weapon'. Weapons will be bits and bytes, but may still have direct or indirect lethal effects. Such attacks not only affect the military, but also civilian entities as demonstrated by the 2007 cyberattacks on Estonia. In 2008 NATO adopted its cyberdefence policy and a NATO Centre of Excellence in Cyber Defence has been set up in Estonia. The establishment of virtual borders within the borderless cyberspace will be challenging.

Impact on the EDTIB. Information protection will be among the top priorities for defence organisations. This could turn out to be a great challenge, and it may have general effects that make actors rather sceptical against transborder cooperation and work against the EDTIB goals of more cooperation and harmonisation.

D.14 Intelligent logistics

Description. Supply chains are very important for the military and they have to be fast and reliable. Information technology is a key element to modern defence logistics. Satellite navigation support and terrain information à la Google Earth increase the speed of coordination and tactical planning. More precise, ubiquitous and even faster logistics and navigational information systems are to be expected. Also here the relationship between civilian technologies (MOTS/COTS) may be important. The German Bundeswehr, for example, is discussing to outsource large parts of its transport and logistics activities to private/civilian companies.

One important aspect in coalition operations is the interoperability of information systems. In the classical military logic, it has always been important to make sure one's own systems were not compatible with those of a potential opponent, whereas the new logic of larger international alliances calls for increased harmonisation.

Factors of influence. There is a distinction between logistics for defence (e.g. transport of goods between different sites and headquarters) and the logistics provided by defence (e.g. airlifts, assistance in humanitarian aid distribution). While the former has become

quite costly and may be outsourced in some instances, the latter could become even more important for defence, because civilian entities often lack the necessary special equipment. Of course, not all kinds of defence-internal logistics can be outsourced for security reasons. RFID technology, computer assistance, satellite navigation and automatisation are already an essential part of modern logistics and supply chain management.

Possible evolutions. Defence could increasingly look for civilian partners and modern supply chain management concepts to assist in their internal logistics needs. The cooperation between defence forces and providers of humanitarian aid (e.g. UN organisations or NGOs) is likely to become more important, necessitating new forms of coordination by integrating different and diverse groups of actors.

Impact on the EDTIB. The establishment of a strong EDTIB could contribute to an overall improvement of logistics and supply chain management, thus enhancing the security of supply and reducing costs. Cooperation and harmonisation of activities are a precondition. Civilian actors are also likely to play an important role in these domains.

D.15 Life cycle management

Description: Life cycle management deals with the continuous improvement of developing, procuring, and sustaining an army's weapons systems. Improving life cycle management is one of the key points leading to a vision of an EDTIB. It includes demand consolidation, ensuring security supply and cost reductions. Europe's investments in their DTIBs have declined, as did the overall defence expenditures. An example of innovation in this field is the introduction of scanning technology and diagnostics systems for the timely identification and possibly self-repair of (potential) defects. Advanced materials will improve the durability of equipment. Scientific research in material science and ICT points towards the future availability of self-diagnostics and self-healing materials.

Factors of influence. The ability of the military to follow innovations in the civilian domain very much depends on the military R&D budget.

Possible evolutions. The limited defence budgets in Europe have turned life cycle maintenance and modernisation into challenging activities. The formation of the EDTIB has been proposed to cope with these challenges and to create more efficiency in procurement and modernisation.

Impact on the EDTIB. It would be the role of a strong, efficient and effective EDTIB to improve the life cycle management of European defence, enabling more efficiency, cost reduction, modernisation and innovation through cooperation, joint R&D and constructive competition of industries.

D.16 Munition management

Description. Munition management includes the safe, effective and efficient distribution of munition (logistics), their storage, handling, detection and defusing as well as recycling. Complex weaponry includes the use of more diverse and complex munition, requiring more sophisticated munition management. Also, in this area

simulations may help in training the handling of munition and assist in capacity planning.

The defusing of munition and weapons (e.g. land mines) as well as environmental considerations (reducing soil contamination by heavy metals in shells) are being addressed by the military. Demining is still very dangerous for humans, so that it has been proposed to deploy robots for this task. This requires advanced sensor and detection systems.

Factors of influence. Environmental and ethical concerns, e.g. over cluster munitions and landmines, are growing and make munition management part of the defence forces' responsibility towards citizens.

Possible evolutions. Automation and computer assistance will become increasingly important for munition management as weapons systems are becoming more complex.

For mine detection, currently living animals like dogs, rats and even bees and plants are being used. Advances in biomimetic sensor systems could lead to artificial sensor systems capable of these tasks. The closest thing to such a development are genetically engineered bacteria that react to TNT.

Impact on the EDTIB. Ammunitions management is a complex task. It is also closely related to the requirement for simulations, advanced training and logistics. Concerns over environmental issues also lead to new developments in munitions.

D.17 Shared situational awareness

Description. Shared Situational Awareness (SSA) is the capability of comprehending complex data from the environment and to extract from these the correct conclusions about immediate future developments. The concept of situational awareness becomes increasingly important, since the civilian and military operating environments are becoming ever more complex. SSA necessitates team coordination where a core of perception is shared by all team members, each of them also possessing a complementary set of situational information. SSA stands in close relation to the developments in military information expert systems mentioned above.

One important technological area for SSA consists of a diverse range of sensors and sensor systems that help to warn military personnel about possible dangers or relevant changes in the environment. Advances in material sciences, miniaturisation, nanotechnology and biotechnology lead to increasingly smaller and sensitive sensors.

Factors of influence. The further improvement of SSA relies on further developments in ICT, networking capacities and human factors research and technologies like augmented reality and shared displays.

Possible evolutions. SSA can be seen as an essential ingredient for networked operations. If the personnel involved in defence operations will become more international, intercultural aspects and differences in perception and communication will also have to be taken into account. The interest in human factors research, which

analyses the ways of human perception and decision-making in order to improve technical systems, is also growing. It may be seen as an important contributor to SSA.

Impact on the EDTIB. SSA, especially in international operations, requires a great deal of harmonisation of information systems and models. The importance of SSA and related technologies (e.g. expert systems, networking) also provides incentives to put more effort into enhancing the joint efforts for improving investments in defence research, technology and development.

E Primes and the EDTIB

This annex will first discuss the strategies of the primes and then attempt to relate these strategies to the EDTIB strategy.

1. Prime strategies

Thales
Thales, headquartered in France and partially owned by the French state, is active in the defence industry as well as in security and aerospace. Thales has for decades relied on the 'multidomestic' strategy. This means they want to act through a domestic affiliate or partner (often a joint venture partner) in order to get a rewarding access to the domestic defence infrastructure. Thales is a global firm; its 68,000 employees operate in more than 50 countries. Half of Thales' staff is employed at locations outside France. Thales aims to be leading in the field of mission-critical information systems, and wants to keep a competitive advantage based on technological excellence.

The company has a dual-technology approach and thereby focuses both on military and civil applications. With 50%, the defence industry is the largest market, while security and aerospace have equal shares of 25%. The revenues in these latter two markets have increased rapidly over the past years. Combining developments in these civilian markets with defence is according to Thales its traditional strength. Over 80% of the revenues of Thales are generated outside France, but of the individual countries the largest share of revenues is still gained in France. Interestingly, the company's revenues in Asia and the pacific in 2007 were higher than its revenues in North America in the same year. A strong growth is expected in expenditures of Asian countries in different markets that are relevant for Thales.

Thales is divided into six divisions: 1) Aerospace, 2) Space, 3) Air systems, 4) Land and joint systems, 5) Naval, and 6) Security solutions and services. The firm also provides components and subsystems. All of these divisions make use of the same technology platform.

Thales is quite active in partnerships as well as in M&As. Through its 2001 joint venture with Raytheon, Thales Raytheon Systems (TRS), the first strategic transatlantic joint venture was created. Most joint ventures are project joint ventures, i.e. they are only geared towards a time-limited specific defence contract. TRS has a strategic vision, namely that the companies cooperate and share long-term goals within a specific product area. Thales made a substantial increase of their UK footprint by acquiring Racal in 2000. Otherwise, business has primarily grown through acquiring medium-sized companies and by expansion through joint ventures.

Thales has had extensive collaboration in the naval sector with French DCNS (previously DCN). DCNS has acquired the joint ventures developed between them. Thales received 25% of the shares in DCNS in return for this divestment.

A few years ago the possibility of Thales merging with EADS was indicated. In 2008, in partnership with German firm Diehl, Thales acquired a production site of Airbus (the Laupheim site) to significantly improve its position as a supplier of aircraft cabins.

Together with Finmeccanica, Thales in 2007 started a project dealing with marine safety and security. Also in 2007, Thales and US-based ACSS initiated a collaboration on transponder development. Since 2007, Thales also has a technology licensing agreement with the British Intercede Group, for identity management and authentication software. Also related to the expansion of the competences of Thales in the field of security appliances is its acquisition in 2008 of nCipher.

Dassault in December 2008 acquired Alcatel-Lucent's 20.9% share in Thales, and this effectively means Dassault has more than 25% of the shares. This will change the strategic future of Thales. Thales is also striving to increase its share in DCNS to above 35%.

In 2008, Thales launched an initiative to become a European UAV leader, stating that Europe needs a European strong UAV capability so as not to be dependent on US UAV capabilities.

EADS

EADS was founded in 2000 as a merger of various companies located in different European countries. Ownership of the firm is partly held by the German, French and Russian governments. Officially, EADS is a Dutch company, but its 116,000 employees are located across the globe. Primary locations and production sites are in France, Germany, Great Britain, Spain, the US and Australia. Over the next decade, EADS aims to expand its businesses in the US and Asia, thereby reducing its relative presence in Europe.

EADS operates in the fields of aerospace, defence and related services. The firm serves both the civilian and military markets. The company is subdivided into four divisions: 1) Airbus (aircraft manufacturing), 2) Eurocopter (helicopters), 3) Astrium (e.g. space satellites), and 4) Defence & Security (defence communication systems and electronics). The company is thus relatively diversified and the Airbus and Eurocopter divisions both offer a civilian and a military range of products. EADS aims to achieve and maintain a competitive advantage by employing a mixed strategy, by being more innovative and proving better quality products, and also by delivering fast and cheap. The company aims to be a technology leader. In 2006, about 6% of its revenues were reinvested in technology development and innovation.

From their website:

"We build on a strong tradition of airborne weapons and missile systems and incorporate state-of-the-art Network Enhanced Capabilities: systems intelligence, integration and expertise. By recognising the need to be mission-critical and security-oriented, we are preparing our customers to meet their new global challenges – whether land-, navy- or air-based."

With respect to the company's revenues, Airbus is by far the largest division, generating over half of total revenues. The aim of EADS is to increase the shares of the other divisions in the overall revenues.

Traditionally, EADS has focused on the development of technologies and technology platforms. Related services are, however, perceived to be an interesting opportunity for growth as they are counter-cyclical and potentially highly profitable. The 2020 aim of

EADS is therefore to expand its services business to generate 25% share of revenues (up from current 10%).

The largest share of revenues of EADS is achieved in Europe (45% in 2007), followed by Asia and the Pacific (23% in 2007) and North America (20% in 2007). The large majority of sourcing activity occurs in Europe. Asia, and more specifically India and China are perceived as promising countries for the expansion of sourcing activities in the future.

EADS is highly active in alliances and M&As. EADS has created a joint venture together with the French defence company Nexter (ex-Giat) to implement a transformation of the French army. EADS has repeatedly expressed their strategic intention to become "*a heavyweight in the US defence business*", which appears to be easier said than done. They appear to strive for a major US acquisition, but US authorities seem to be reluctant to approve of American defence technology falling into the hands of a multi-politically influenced European company. EADS in 2008 acquired US PlantCML ($350 million), which increased its US footprint, but is not enough for EADS.

A very large project in the US is the acquisition of air-to-air tanker aircraft. EADS was awarded the KC-X replacement contract together with Lockheed Martin, but this deal was revoked in 2008 after a period of politically and US protectionist coloured debate. The entire acquisition was cancelled later in 2008. These problems highlighted the difficulty in getting approval of all concerned US authorities and vested interests, especially Congress.

EADS also aims for a long-term strategic relation with China. At the beginning of 2009 a joint venture was established with several industrial partners from China to set up a manufacturing site for Airbus components in Harbin. This action contributes to the achievement of the EADS target of producing 5% of the A350 XWB airframe in China.

BAE Systems

BAE Systems (BAE) headquarters is located in the UK and employs about 105,000 people. It is entirely privately owned, but its extent of foreign ownership is limited by law to 29.5%. BAE is active in defence, aerospace systems and security. The latter has been an important area of business diversification since 2007. BAE holds its strongest positions in its six home markets: Australia, Saudi Arabia, South Africa, Sweden, UK and US.

From their 2007 Annual Report:

"BAE Systems is a global company with a strategy currently focused around six home markets. Together these home markets were responsible for generating 85% of Group sales in 2007 (2006 84%)."

In 2007, BAE's business groups were Electronics, Intelligence & Support, Land & Armaments, Programmes & Support, International Businesses and HQ & Other Businesses, of which Programmes & Support generated the highest sales. Second highest were the sales of the business group Electronics, Intelligence & Support.

Currently, BAE employs a business model comprised of five strategic areas: 1) Information, networked and autonomous systems, 2) Design and materials technologies, 3) Sensors and electronics, 4) Specialist manufacture and technical services, 5) Systems engineering.

With a combination of "organic investments and acquisitions" BAE aims to address new market opportunities. The US is considered to be the most attractive defence market, as 50% of the budgets in markets that are covered by BAE are US budgets. These US budgets are thought to be stable in the coming years. Therefore, BAE has decided to aim for a growth of business in the US, also partly through acquisitions and opening up facilities in the US. For instance, in 2008 a new facility was established in Alabama, for the production of large components of armaments for the new US Navy Destroyer. At the beginning of 2009 BAE opened a new facility in Austin, Texas for the development and production of armour kits to protect ground vehicles of the US Army. Around the same time, BAE opened up an innovation centre in Honolulu where 1,000 employees will be stationed.

In 2008, BAE took an important step in obtaining a strong position in the Australian defence industry by acquiring Tenix Defence. With this acquisition, BAE hopes to strengthen its relations with the Australian Defence Force. The company is also investing in a further expansion of its activities in Saudi Arabia.

Finmeccanica

Finmeccanica is headquartered in Italy and operates in the aerospace, defence and security sectors. The company has over 70,000 employees in Italy (over 42,000 in 2007), the UK (about 10,000 in 2007), the rest of Europe and the US (about 2,000 in 2007). The Italian state owns one third of Finmeccanica. The company does not solely focus on military applications of its technologies, but sets up so-called dual-technology projects from which civilian applications also derive. About 14% of the firm's revenues are reinvested in technology development and innovation.

From their homepage:

"*Finmeccanica is the main Italian industrial group operating globally in the aerospace, defence and security sectors, and is one of the world's leading groups in the fields of helicopters and defence electronics. It is also the European leader for satellite and space services as well as having considerable know-how and production capacity in the energy and transport fields.*

A large part of R&D investment is channelled into dual-technology projects, leading to significant advantages in civil applications of considerable strategic importance. To maintain its leadership in hi-tech sectors, Finmeccanica focuses on the value of its human resources, and the laboratories of its subsidiaries are staffed by around 3,000 highly specialized researchers."

Finmeccania is subdivided into six departments: Aeronautics, Helicopters, Space, Defence electronics, Defence systems and Energy and transportation. Within the fields of Aeronautics, Helicopters and Energy and transportation civilian as well as military applications are developed. In 2007, the highest revenues were generated by Defence electronics (29%), followed by Helicopters (22%) and Energy and transportation (18%). Compared to 2006, Aeronautics and Space were the two departments that experienced the highest growth in revenues (21% and 12%, respectively). In 2007, the largest

investments were made in the Aeronautics department (€ mil. 326), followed by Helicopters (€ mil. 109), Defence electronics (€ mil. 98) and Defence systems (€ mil. 25).

In the field of Space, Finmeccanica has an important partnership with Thales. This joint venture named Thales Alenia Space is focused on satellite systems and other orbital infrastructures. Finmeccanica owns the helicopter producer AgustaWestland which has a UK plant (formerly Westland helicopters at Yeovil). AgustaWestland in 2005 sold helicopters to the US Marine One presidential transport fleet, a great strategic success.

With regard to its markets, Finmeccanica indicates that demands in the military sector in Europe have decreased over the past years, especially in Italy. However, the potential markets in developing countries and the US have become larger. This has increased Finmeccanica's focus on the US. Next to the US, Russia, China, India and the Middle East are also important markets. During 2008, they performed a fundamental breakthrough in creating a US presence through their € 5,2 billion acquisition of DRS Technologies. To finance this transaction, they divested a non-core entity (a power plant producer) from Finmeccanica in Italy.

Finmeccanica's strategic objectives for the coming period are to further strengthen its position in its existing markets, to increase the company's internationalisation by doubling the export rate and to stimulate product innovation through further development of enabling technologies. They focus on "organic growth driven by expanding international footprint", i.e. not primarily growth by acquisition. Significant direct investments are made in alliances with partners from the US, Russia, France and the UK. In general, Finmeccanica is most active in countries where a significant presence has already been established.

2. Primes and the EDTIB

The primes form a critical element in the European EDTIB. Employing close to 400,000 employees directly and an even much larger number indirectly (a BIPE study estimated total employment in the EDTIB to be approximately 1,6 million) they retain and develop a huge knowledge and skill base.

This skill base, spread all over Europe (and beyond), is deployed in the development of critical platforms, systems and subsystems for defence, although a significant increase can be seen in investments in security, increasingly developing and deploying their dual-use capacity. Another interesting and related development is the increase in services, a development also seen in the regular industry.

A further interesting aspect concerning the portfolio management of the primes is that only one of them depends for more than 50% on the defence market. The others maintain a significant exposure in the civil market as well. The civil market often being aerospace, space and security, trying to make optimal use of the opportunities of dual use.

All of them having a multidomestic footprint in Europe, they should be able to benefit from the defence directive on intra-EU trade. Related to this is the issue of sourcing. They still mainly source from within (Western) Europe, in that way supporting a supplier base, but increasingly (under pressure of globalisation), they source from outside Europe as well (EADS for instance for already 40%).