Assessment of the Satellite Equipment Sector in the ESA Member States

Executive Summary

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Introduction

Objectives of the study

The key objectives of the study are the following:

- to evaluate the European satellite equipment industry in today's very complex, competitive, and international environment, particularly in relation to the integration strategy of European prime contractors;
- to give a clear picture of the stakes, risks, and opportunities for European equipment suppliers;
- to provide the ESA, national policy makers, and industry with objective and consolidated data in order to support the on-going dialogue between prime contractors and equipment suppliers;
- to recommend to the ESA and national policy-makers the optimal actions to adopt in view of the necessary restructuring of the sector to ensure European suppliers' competitiveness in the international market.

Method of the study – international survey

The study was based on a comprehensive international survey, covering practically all European industrial players working on satellite equipment hardware:

- all key satellite equipment suppliers selected in the ESA Member States and Canada (see list of the 66 companies finally retained), representing an estimated 95% to 98% of the European satellite equipment supply industry, as well as
- all European prime contractors: Alcatel SPace Industries (ASPI), Alenia Spazio, DaimlerChrysler Aerospace (DASA/Dornier), and Matra Marconi Space (MMS).

The survey consisted of detailed and repeated interviews with the persons responsible for equipment activity. About 120 persons directly interfaced with Euroconsult for interviews (see table), while more than 300 specialists within the companies contributed to data collection and consolidation, creating a real mobilisation in the ESA Member States and Canada.

During the interviews, a multi-criteria approach of quantitative and qualitative issues was used: space and satellite business, corporate and shareholding information, market information, competition, technology and R&D efforts, fields of excellence, synergies and external relations, assessments of threats to their business, presence of possible conflicts with Primes, judgement on the corrective actions the ESA could take to increase competitiveness, etc. This thorough work resulted in an understanding of the entire range of capabilities, heritage, status, and prospects of the satellite equipment activity of each company, as well as its concerns and expectations.

In regards to the detailed competencies of each company in various satellite equipment, an additional, specific campaign of interviews was carried out with the same persons, in order to consolidate a complete and authorised mapping of European capabilities.

Satellite equipment suppliers in the ESA Member States & Canada participating in the survey (66 companies)

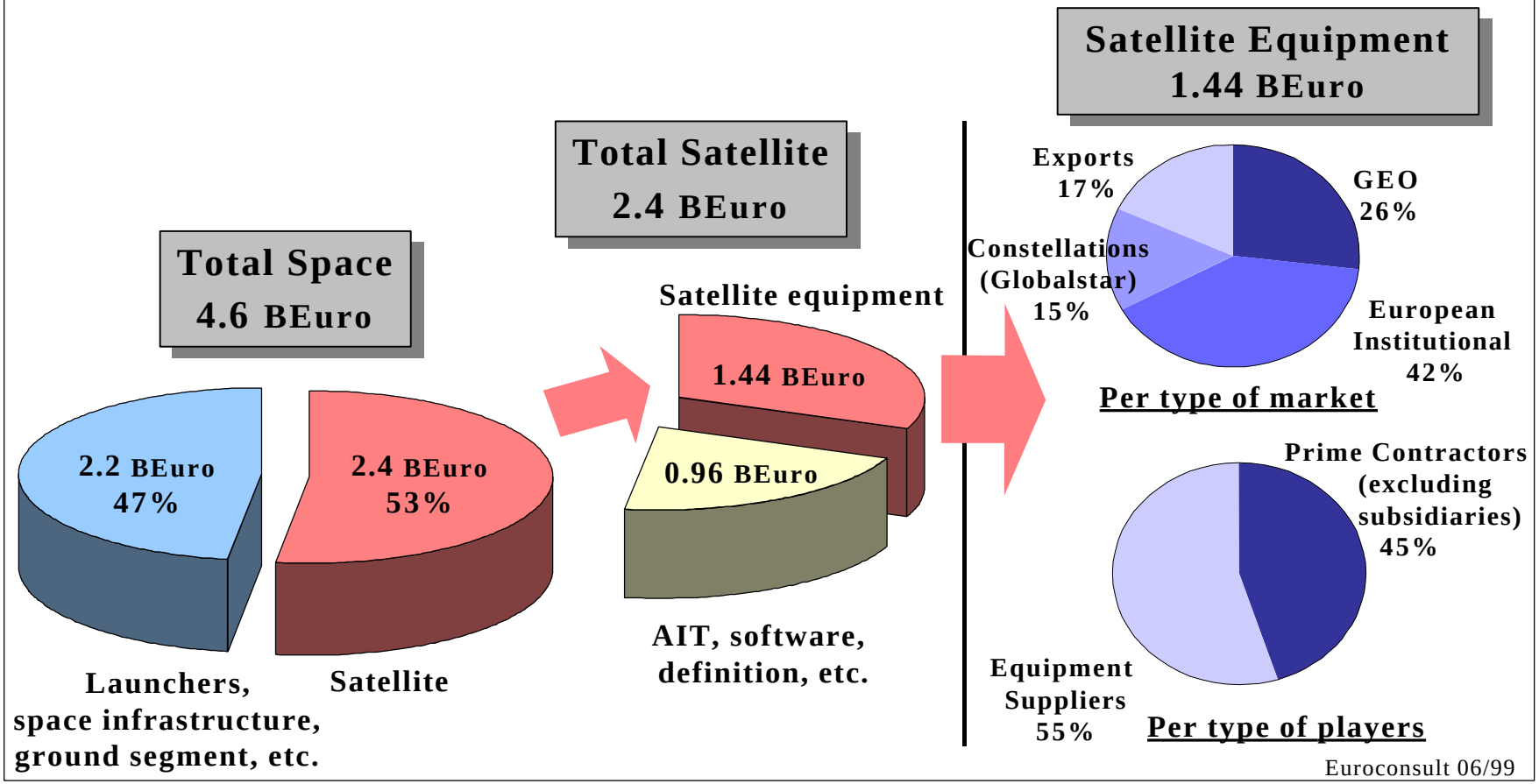
PR/S	Companies related to prime contractors (PR) or Subsidiaries (S) of Primes.
LG	Companies belonging to large industrial groups other than Primes.
IN	Companies independent of Primes or other large groups.

AUSTRIA (1)	**LG**	Austrian Aerospace			
BELGIUM (5)	PR/S	Alcatel ETCA	**LG**	SONACA	
	PR/S	Alcatel Bell	IN	Verhaert Design & Development	
	LG	SABCA			
DENMARK (3)	PR/S	Alcatel Denmark	**LG**	Terma Elektronik	
	LG	Per Udsen (Terma Ind Grenaa)			
FINLAND (2)	**LG**	Patria Finavitec Oy.	IN	Ylinen Electronics Co.	
FRANCE (10)	PR	Dassault Aviation	**LG**	SAGEM S.A.	
	PR	Dassault Electronique	**LG**	SEP, SNECMA Division	
	PR	PyroAlliance	PR	Sextant Avion. (Alcatel-Valence)	
	LG	REOSC (SFIM Industries)	PR/S	Sodern	
	PR	SAFT	PR	Thomson Tubes Electroniques-TTE	
GERMANY (10)	**LG**	ASE GmbH	**LG**	Jenoptik Laser, Optik, Systeme-LOS	
	LG	BOSCH Telekom	IN	Kayser-Threde	
	LG	Carl Zeis Oberkochen	**LG**	MAN Technologie (incl. Zeppelin)	
	PR/S	Daimler-Chr Jena Optronik	IN	OHB System GmbH	
	IN	FPM Space Sensor	**LG**	Teldix	
IRELAND (2)	IN	Captec	IN	Devtec Ltd.	
ITALY (6)	IN	Carlo Gavazzi S.p.A.	PR/S	Laben	
	PR/S	FIAR	**LG**	Oerlikon Contraves Italia	
	LG	Fiat Avio	PR/S	Officine Galileo	
NETHERLAND (2)	IN	Bradford Engineering	IN	Fokker Space	
NORWAY (3)	PR/S	AME Space	**LG**	Raufoss Technology	
	LG	Kongsberg Aerospace			
SPAIN (5)	PR/S	Alcatel Espacio	IN	Mier Comunicaciones S.A.	
	LG	CASA	IN	Rymsa	
	PR/S	Crisa			
SWEDEN (1)	**LG**	SAAB Ericsson Space			
SWITZERLAND (4)	PR/S	CIR	IN	Mecanex	
	IN	Etel S.A.	**LG**	Oerlikon Contraves Space	
UNITED KINGDOM (9)	**LG**	AEA Technology	**LG**	ARC UK Ltd (Royal Ordnance)	
	LG	Com Dev Europe	IN	SIRA	
	LG	Dowty	IN	Space Innovations Ltd.	
	PR	EEV Ltd.	IN	Surrey Satellite Technology Ltd.	
	PR	GEC-Marconi Avionics			
CANADA (3)	**LG**	EMS Techn. Can (CAL Corp.)	**LG**	EMS Techn Can (SPAR Sp. Syst.)	
	LG	Com Dev Canada			

Most representative European space business
Total Space, Satellite and Equipment Activities.

Average consolidated values 1995-97, constellations (Globalstar) for 1997

Surveyed companies represent 95-98% of total satellite equipment activity & 50% of total space activity in ESA Member States



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1. Market evolution and stakes for the European industry

1.1 Ten-year world satellite market projection (1998-2007)

The satellite market shown in the following figures illustrates global activity, excluding institutional (but not commercial) programmes of the CIE countries and China, in order to allow for a better understanding of the relative importance of the various segments in the future.

Strong growth of an already healthy satellite market, thanks to constellations

Projected satellite activity for the first 5 years (1998-2002) is already much stronger than that of the past, but the future (2003-07) seems even brighter in terms of numbers of satellites. A 30% increase in the minimal market between the two 5-year periods. This growth will come from the commercial market, which will account for 2 out of 3 satellites of the minimum potential market size in 1998-2002. This market is theoretically open to global competition and it illustrates its importance for the future of European players.

After a number of years of high activity, the global GEO market will decline in the long term

The market for satellites in GEO is already experiencing a relative slow-down. The pace of the market during the first five-year period is expected to be at 30 to 40 satellites per year world-wide, while a significant drop is expected for the subsequent 5 years (-30% of the total market). This trend would be present in every region of the world. It indicates the stabilisation of demand in the rest of the world, which has fuelled growth so far. Multimedia satellites, especially in the Ka band, are expected to appear in the next few years, while satellites in GEO for mobiles are already appearing.

At best, the institutional world market will stagnate, with the possible exception of ambitious US military programmes

The minimum world market size will stagnate between the two periods (189 versus 196 satellites), while uncertainty regarding small satellite programmes in Europe (100 to 150 kg) and the US military (reconnaissance and intelligence missions) continues. This last market segment promises to be the healthiest of the institutional markets in the coming years, and illustrates the importance of the captive market it creates for the US industry, both for US Primes and US equipment suppliers. The European market includes the Galileo programme with 24 satellites in LEO and 3 in GEO.

The European share will drop from 31% to 23% of the minimum world market

It is expected that the share of the European market (minimum market size in number of satellites) between the two 5-year periods will drop. In fact, during the first 5 years of the period examined (1998-2002), the only European-initiative programmes will be Globalstar (considered European due to its large content in European added value), and the expected launch of the first half of the Skybridge constellation. In the longer term (2003-07), these two programmes will represent a smaller part of the total constellation activity, while it is expected that most projects for world-scale services in the Ka-band will be US initiatives. The European institutional market, will be maintained at a regular pace, under the assumption of the Galileosat programme, and the undertaking of several small-satellite programmes announced by national space agencies.

The major part of the world market will be accessible to the European industry but difficult to conquer

The satellite equipment market accessible to European players corresponds to 71% of the total minimum world market in 1998-2002 (388 satellites versus 546) and 81% for the subsequent 5 years (576 satellites versus 710), due to the increasing openness of the international commercial

market, and to the Galileosat programme. Three major types of market targets are open to the European industry:

- The European institutional market, accounting for about 8 to 11 satellites of more than 100 kg per year, including several satellites of the 100-150 kg class, as well as the Galileo constellation, although there is uncertainty about other big programmes in the longer term.
- The world GEO market, which will be in decline and could be dominated by US-initiative Ka-band satellites for new services. This market already includes several satellites for US prime contractors, acting as world-wide service operators (i.e., Hughes, Lockheed Martin, Space Systems/Loral).
- The constellations market, despite recent problems of the Iridium and ICO programmes, is the most promising segment in terms of numbers of satellites and equipment a company could supply. However, this multi-billion dollar market often obeys the logic of risk-sharing partnerships of manufacturers participating in the construction of satellites, a novel concept to most European equipment suppliers. Participation in the programmes of Skybridge and/or Teledesic seems a key element for the success of equipment manufacturers wishing to enter the constellations market.

1.2 Satellite equipment market projection (1998-2007)

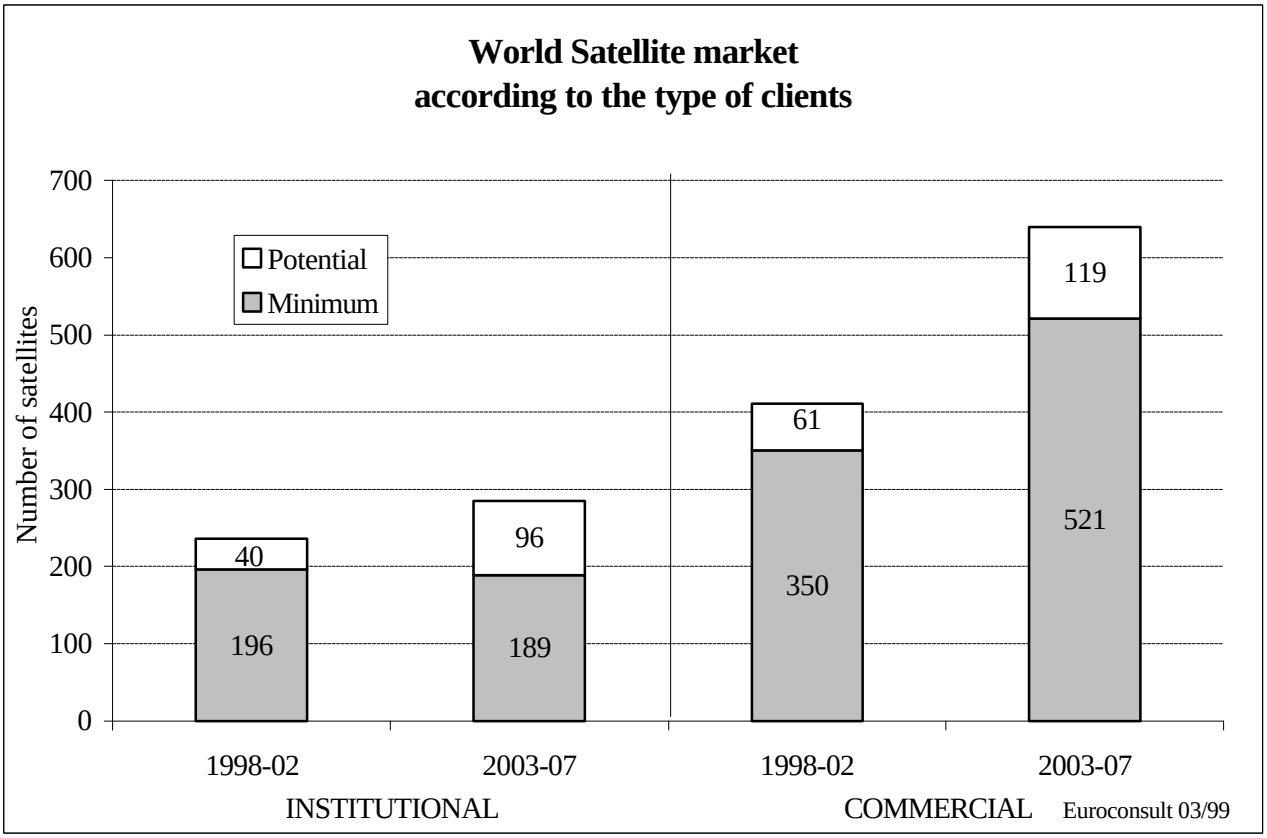
A meaningful assessment in terms of equipment value is only possible, though approximate, in the case of the relatively well-known market of telecommunications satellites in the GEO orbit. In fact, prices and price evolution of equipment for this type of satellites have been known for a number of years and a projection is thus possible, under various assumptions (changes in market needs, in technology, in productivity, etc.). The values indicated are approximate average world figures over the entire period studied, and they were also used to establish the figure in Chapter 5. A similar assessment for other key markets would not have been meaningful: institutional satellites often use specific equipment, while the constellation market presents low visibility of the type and number of equipment to be used and their price evolution.

Average annual world market for key equipment (communications satellites in GEO)

10-year period 1998-2007 (Euros in millions per year)

Bus	
Equipment	**Market value**
Onboard Management	90
Inertial wheels (mechanical)	15
Gyros	30
Earth sensors	30
Sun sensors	15
TT&C antennae	15
TT&C transponders	45
Solar generators	165
Batteries	45
BAPTAs	10
Power Conditioning & Distr.	60
ABMs	9
Chemical thrusters	30
Tanks	25
Tubes, valves, etc.	5
Electric propulsion subsystem	60
Thermal control	25
Structures	90

Payload	
Equipment	**Market value**
Antennae (entire)	180
TWT	100
EPC	110
SSPA	15
Reception RF equipment	150
OMUX/IMUX	60
Channel amplifiers	80
Other RF equipment	290
Switches	7
Onboard processors	100


World Satellite market
according to the type of clients
Number of satellites
700
600
500
400
300
200
100
0
Potential
Minimum
40
196
96
189
61
350
119
521
1998-02
2003-07
1998-02
2003-07
INSTITUTIONAL
COMMERCIAL
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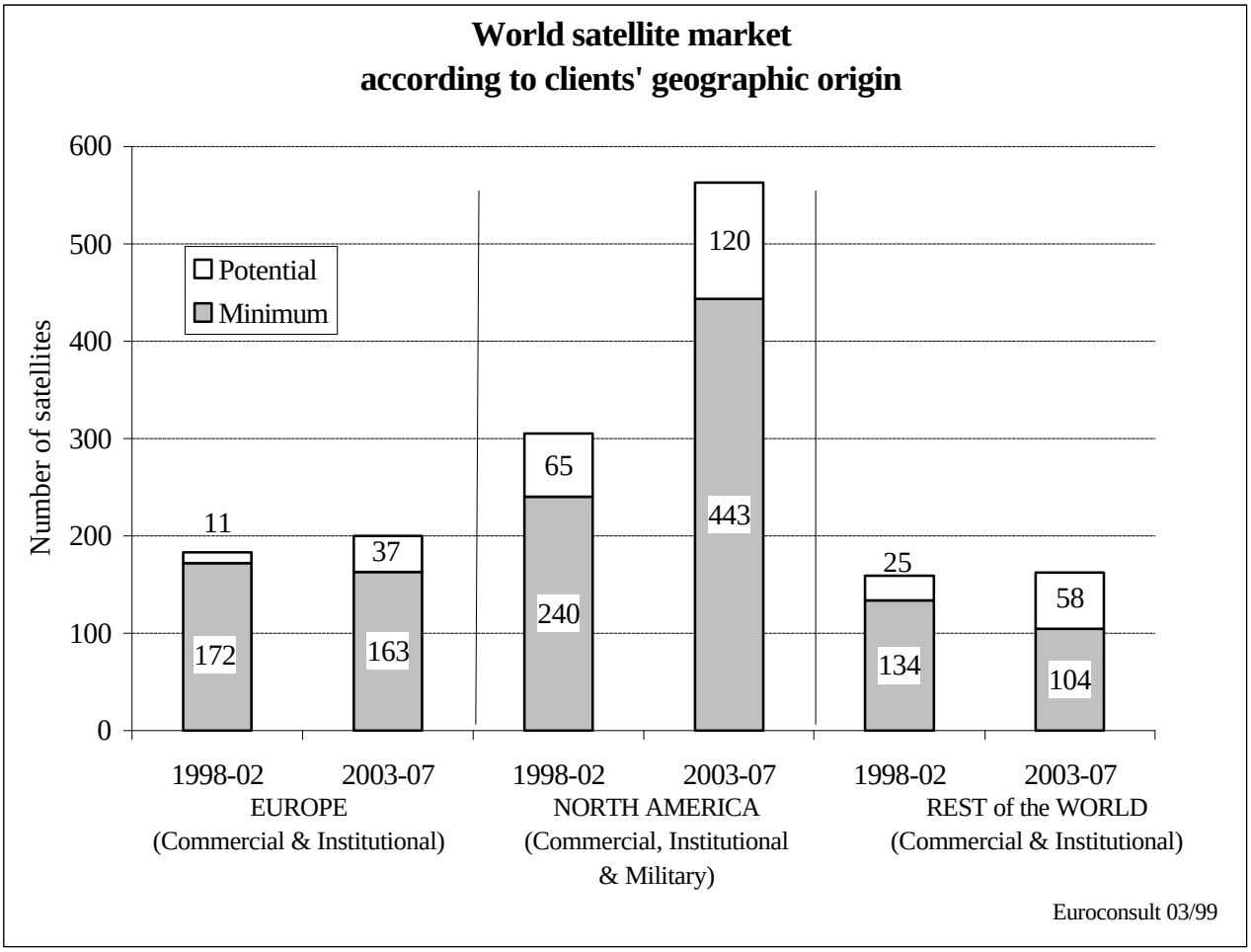
World satellite market
according to clients' geographic origin
Number of satellites
600
500
400
300
200
100
0
Potential
Minimum
11
172
37
163
65
240
120
443
25
134
58
104
1998-02
2003-07
1998-02
2003-07
1998-02
2003-07
EUROPE
(Commercial & Institutional)
NORTH AMERICA
(Commercial, Institutional
& Military)
REST of the WORLD
(Commercial & Institutional)
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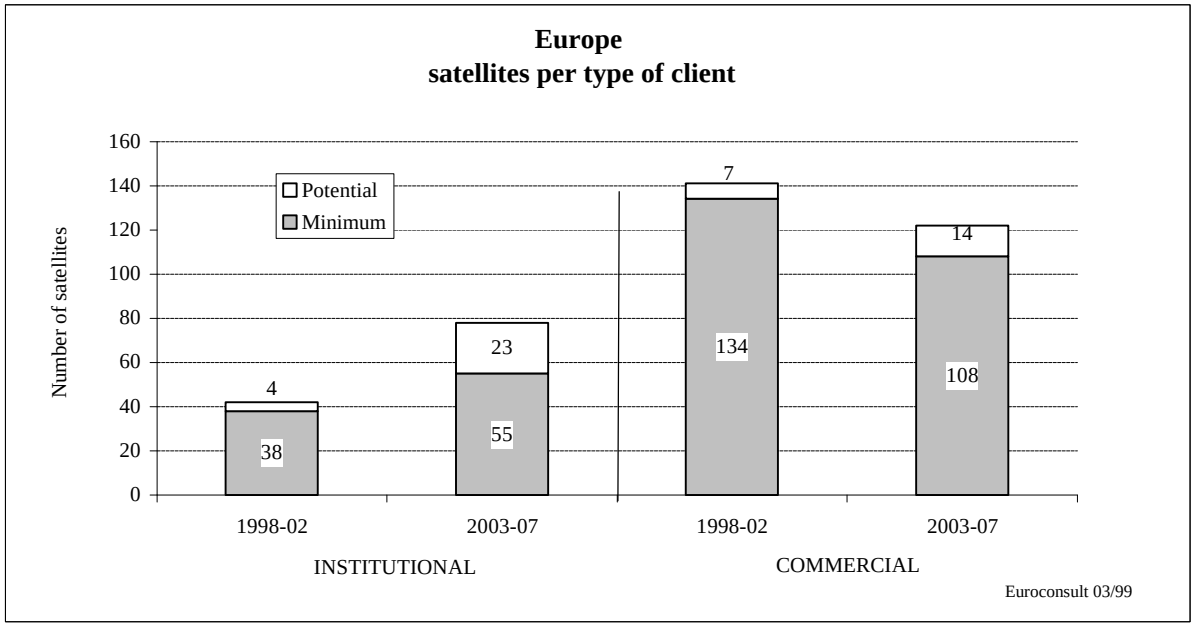
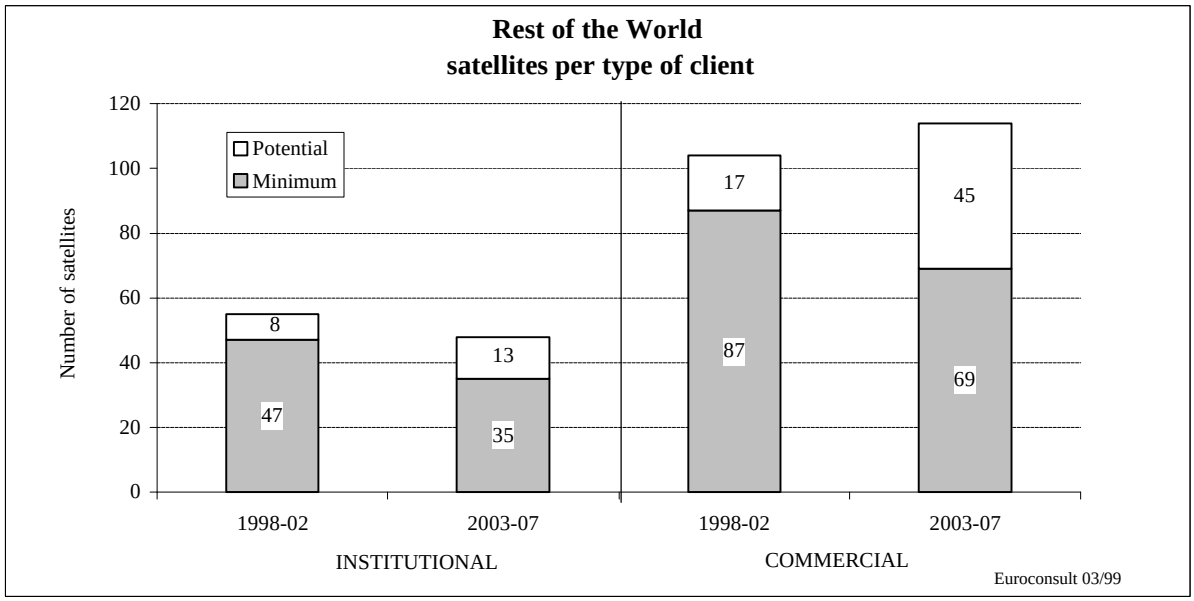
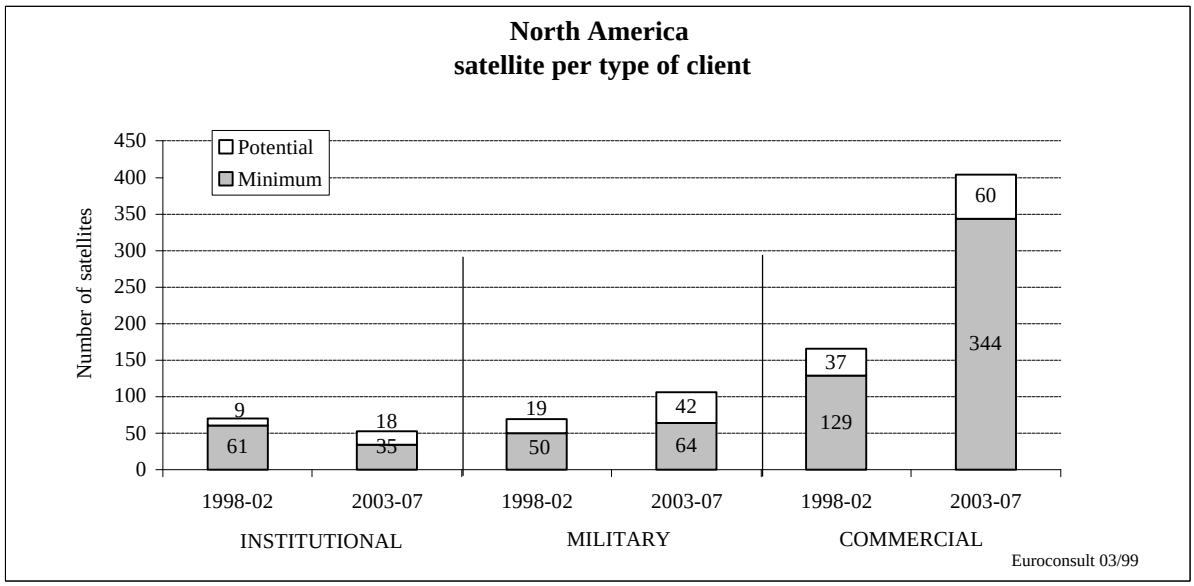

Europe
satellites per type of client
Number of satellites
160
140
120
100
80
60
40
20
0
Potential
Minimum
4
38
23
55
7
134
14
108
1998-02
2003-07
1998-02
2003-07
INSTITUTIONAL
COMMERCIAL
Euroconsult 03/99


Rest of the World
satellites per type of client
Number of satellites
120
100
80
60
40
20
0
Potential
Minimum
8
47
13
35
17
87
45
69
1998-02
2003-07
1998-02
2003-07
INSTITUTIONAL
COMMERCIAL
Euroconsult 03/99


North America
satellite per type of client
Number of satellites
450
400
350
300
250
200
150
100
50
0
Potential
Minimum
9
61
18
35
19
50
42
64
37
129
60
344
1998-02
2003-07
1998-02
2003-07
1998-02
2003-07
INSTITUTIONAL
MILITARY
COMMERCIAL
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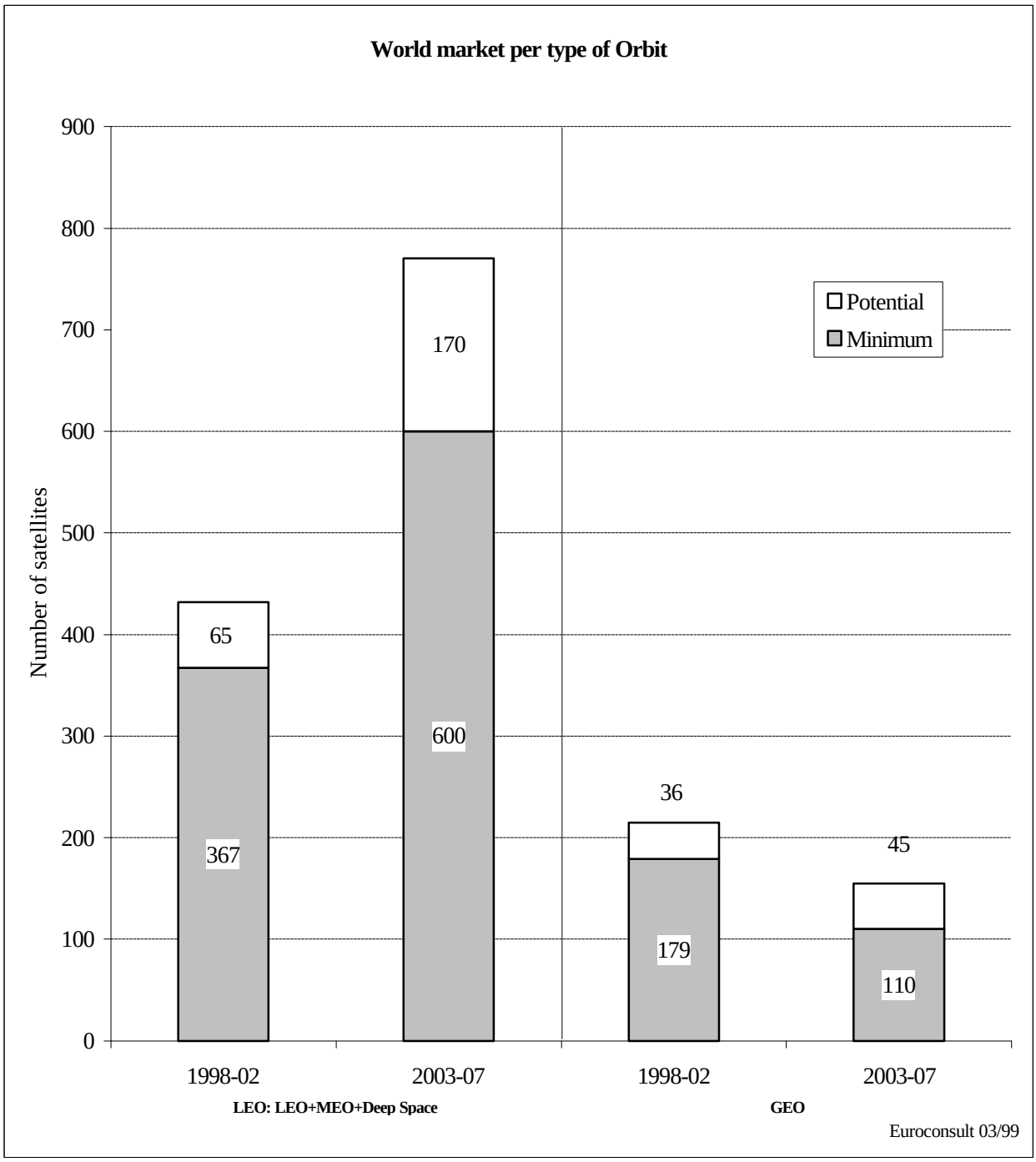
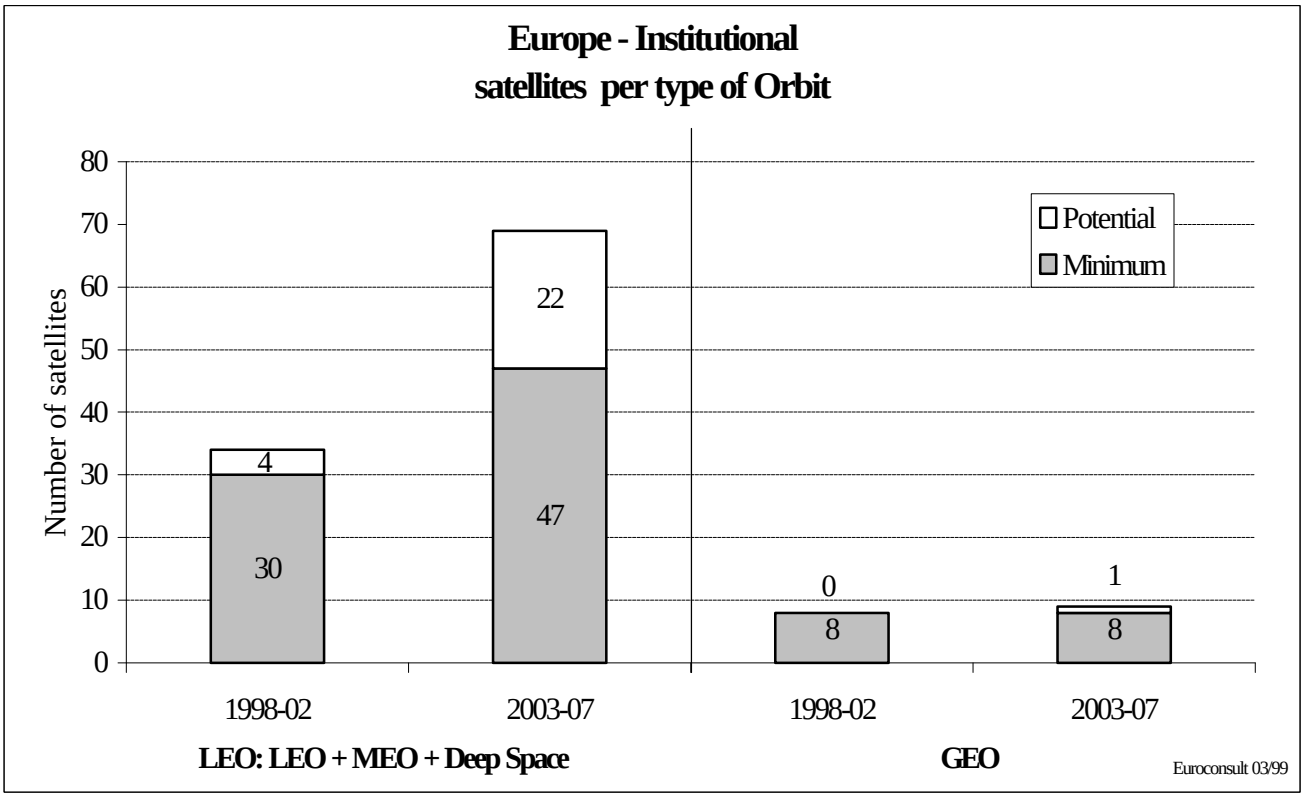
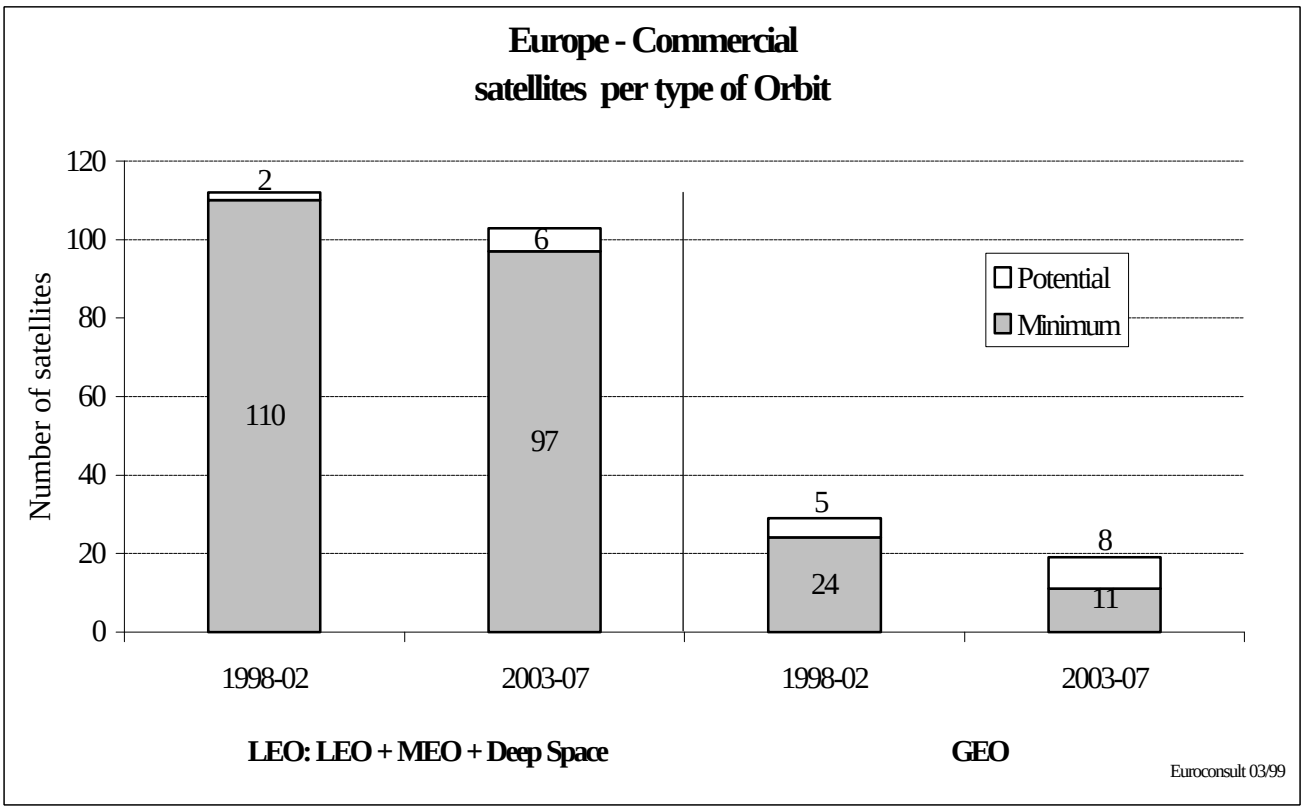

World market per type of Orbit
900
800
700
600
500
400
300
200
100
0
Number of satellites
Potential
Minimum
65
367
170
600
36
179
45
110
1998-02
2003-07
1998-02
2003-07
LEO: LEO+MEO+Deep Space
GEO
Euroconsult 03/99


Europe - Institutional
satellites per type of Orbit
Number of satellites
80
70
60
50
40
30
20
10
0
Potential
Minimum
4
30
22
47
0
8
1
8
1998-02
2003-07
1998-02
2003-07
LEO: LEO + MEO + Deep Space
GEO
Euroconsult 03/99


Europe - Commercial
satellites per type of Orbit
Number of satellites
120
100
80
60
40
20
0
Potential
Minimum
2
110
6
97
5
24
8
11
1998-02
2003-07
1998-02
2003-07
LEO: LEO + MEO + Deep Space
GEO
Euroconsult 03/99

2. Analysis of European equipment suppliers

The international survey was designed for and has provided both qualitative and quantitative information on the various issues concerning the European satellite equipment industry:

- **The presence** of the European suppliers in the manufacturing of various satellite equipment; it will indicate who is doing what in the ESA Member States and Canada.

- **The performance** of the European suppliers (turnover, types of markets, export activity, past and future R&D efforts, marketing efforts, etc.). A large number of companies have relatively low turnover in the satellite equipment business (32 companies with annual satellite equipment sales of less than 5 MEuro), and they are analysed separately. In addition, the key characteristics of the small satellite business are highlighted (9 companies).

2.1 Great diversity of European products and players

The spectrum of possibilities was distinguished and presented at two different levels:

- **degree of preparation** of a company to manufacture a given equipment:
  - production in the past (before 1995), with no sales since then;
  - effective production during the last four years (1995-98);
  - future capability to produce a type of equipment.

- **degree of involvement** in equipment manufacturing:
  - suppliers manufacturing and responsible for the entire equipment, and
  - suppliers manufacturing parts of equipment, or responsible for one phase of integration.

Wide spectrum of competencies among suppliers

For practically every piece of equipment, there is at least one company (except for large antenna reflectors), and often several companies with present, past, or future manufacturing capabilities (entire equipment or equipment parts), and every possible situation can be found:

- **companies with low levels of satellite equipment sales** constitute the majority of equipment suppliers:
  - some companies are present in the manufacturing of several types of satellite equipment, indicating most often the results of prototyping work done for institutional programs, depending on the mission.
  - other companies, which have more specialised capabilities, in one or a limited number of, equipment or equipment parts, are generally more present in commercial markets;
- **suppliers with important sales**
  - can be specialists in one or a very limited number of types of equipment; or, on the contrary, they can cover a large equipment family. They can be strong players in the world competitive environment (TTE, Dowty, or Saft, for one specialised equipment; or Bosch Telekom, Saab Ericsson, etc. for large equipment families);
  - others are more dependent on institutional programs (Laben, Austrian Aerospace, etc.);
- **companies working exclusively in small satellites** often have an impressive array of capabilities for adapted equipment, indicating a self-sufficiency in the manufacturing of their own satellites, rather than efforts to sell standard equipment to several clients;
- **manufacturing of equipment parts** is common, as is also the case for companies working in «other», lower-level equipment or large components (pyrotechnic devices, electric motors, smaller-sized mechanical parts, DC/DC converters, and other RF equipment parts, scientific equipment parts, etc.) and illustrates the satellite equipment suppliers' diversity and flexibility.

With the exception of some commercial successes for equipment parts, or lower-level equipment, companies in these fields most often supply institutional programmes;

- **plans for future manufacturing** capabilities are also common (especially for telecommunications equipment) showing the interest suppliers have in entering the most promising and attractive market;
- **past capabilities**, which have not been recently used, are the result of previous programmes. and they occur rather rarely. They constitute a source of dormant capabilities, easily reactivated in case of future opportunities.
- **a strong presence is obviously observed in equipment for Earth observation and scientific payloads**, as they constitute the vast majority of institutional missions.

The often large number of suppliers present for the majority of equipment (see figures) illustrates the fragmentation of the European supply industry. However, it should not be solely interpreted as a redundancy of sources for identical pieces of equipment. The diversity found in each supplier's technological origins and innovation capabilities, as well as the diversity of technical specifications required for the various institutional missions and commercial markets, created a wide spectrum of similar, but not identical, pieces of equipment or equipment parts.

European prime contractors (excluding subsidiaries) also have a vast array of competencies and capabilities, as can be seen in the same figures. They all benefit from a very long technological heritage in adjacent fields (defence, telecommunications, aeronautics, electronics, etc.) and from a long experience in the space field. The end result is a capability to manufacture practically all satellite equipment, especially in the Astrium group (combined capabilities of MMS France and UK, DASA/Dornier and Alenia), while ASPI is absent from satellite propulsion. Parent companies of both Prime groups are not very present in AOCS sensors though, and are entirely absent from a few areas (stellar and Earth sensors, TWTs and switches).

2.2 Good overall performance of the European equipment supply industry

Largest share of sales to European institutional programmes

The European satellite equipment supply industry (equipment hardware level, excluding AIT, software, etc.) accounted (on average) for 800 MEuro per year during the last three years, or 55% of the total. The rest of the production (45%) was carried out by prime contractors (parent companies, excluding subsidiaries). The major part of this equipment supply business came from sales to European institutional programmes (460 MEuro or 58%), while the rest of it was equally divided between sales to European Primes for satellites in GEO and to non-European Primes (153 MEuro or 19%, and 167 MEuro or 21% respectively). The participation of European suppliers in the Globalstar programme was very low (approximately 20 MEuro or 3% of total).

Average sales per company amount to about 12.5 MEuro, but very large differences exist between suppliers, both in their total satellite equipment business and in their relative performance in commercial markets and exports.

Commercial success is due to few companies from few countries

European equipment suppliers demonstrated in the last few years good overall performance. They have strong export activity, selling more to non-European Primes than to European Primes (167 MEuro, versus 153 MEuro). The commercial trade balance for Europe of this sector is very positive (only 70 MEuro of imports at equipment level from non-European sources). This good performance is the result of a small number of suppliers, some of them among the world specialists (TTE, Bosch Telecom, SAFT, Saab Ericsson Space, Fokker Space, Teldix, Royal Ordnance (now ARC UK Ltd), Officine Galileo, ASE, AME Space, Dowty, etc.). The same companies are also the most active in

Production Capabilities and Competencies of Satellite Equipment Suppliers in ESA's Member States and Canada

Effective production (95-98)

Production capability - no recent sales

Possible or anticipated future capability

Production/capability for equipment parts

S Companies working exclusively or quasi-exclusively on smallsats (<300kg)

Elements provided by the companies

Satellite Bus - All applications

			OB Mgmt			AOCS								TT&C		Power Supply				Chemical Propulsion					Electric Propulsion				Thermal Control										
			Onboard computer	Decoder/Remote command	Remote Terminal Unit (RTU)	AOCS computer	Inertial wheels-mechanical	Inertial wheels-magnetic	Gyros	Stellar sensors	Sun sensors	Earth sensors	GPS	Transponders	TT&C antennas	Solar Generator	BAPTAs	Batteries	Power Condit/Distrib.	Apogee Motors	Chemical Thrusters	Command Electronics	Tanks (propel., press.)	Tubes, valves, etc.	Electric Thrusters	Power conditioning	Xe Tanks	Pointing systems	Thermal blankets	Radiation panels	OSRs, filters, etc.	Single loops	Two-phase loops	Heat pipes	Coolers	Heaters, louvers	**Structures**	**Other equipment**
Austria	Austrian Aerospace																																					
Belgium	Alcatel ETCA																																					
	Alcatel Bell																																					
	Sabca																																					
	SONACA																																					
	VDD	S																																				
Denmark	Alcatel Denmark																																					
	Per Udsen Co.	S																																				
	Terma Elektronik AS																																					
Finland	Patria Finavitec																																					
	Ylinen Electrics Co.																																					
France	Dassault Aviation																																					
	Dassault Electronique																																					
	Pyroalliance																																					
	REOSC																																					
	SAFT																																					
	SAGEM SA																																					
	SEP - SNECMA Division																																					
	Sextant Avionique - ASPI Valence																																					
	Sodern																																					
	TTE																																					
Germany	ASE																																					
	Bosch Telekom																																					
	Carl Zeiss Oberkochen																																					
	Daimler-Chrysler Jena-Optronik																																					
	FPM	S																																				
	Jenoptik L.O.S																																					
	Kayser-Threde	S																																				
	Man Technologie (incl. Zeppelin)																																					
	OHB System	S																																				
	Teldix																																					
Ireland	Captec Ltd																																					
	Devtec																																					

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Production Capabilities and Competencies of Satellite Equipment Suppliers in ESA's Member States and Canada

Satellite Bus - All applications - Cont'd

Effective production (95-98)

Production capability - no recent sales

Possible or anticipated future capability

Production/capability for equipment parts

S Companies working exclusively or quasi-exclusively on smallsats (<300kg)

Elements provided by the companies

			OB Mgmt			AOCS								TT&C		Power Supply				Chemical Propulsion					Electric Propulsion				Thermal Control										
			Onboard computer	Decoder/Remote command	Remote Terminal Unit (RTU)	AOCS computer	Inertial wheels-mechanical	Inertial wheels-magnetic	Gyros	Stellar sensors	Sun sensors	Earth sensors	GPS	Transponders	TT&C antennas	Solar Generator	BAPTAs	Batteries	Power Condit/Distrib.	Apogee Motors	Chemical Thrusters	Command Electronics	Tanks (propel., press.)	Tubes, valves, etc.	Electric Thrusters	Power conditioning	Xe Tanks	Pointing systems	Thermal blankets	Radiation panels	OSRs, filters, etc.	Single loops	Two-phase loops	Heat pipes	Coolers	Heaters, louvers	Structures	Other equipment
Italy	Carlo Gavazzi Space	S	■			■										■			■																			
	FIAR															■		■	■							■												
	Fiat Avio																			■	■				■												■	■
	Laben		■	■	■	■							■						■			■			■													
	Oerlikon Contraves SpA	S														■	■																				■	
	Officine Galileo									■	■	■																										
Netherlands	Bradford Engineering																							■														■
	Fokker Space															■														■				■		■	■
Norway	AME Space																		■																		
	Kongsberg Defence & Aerospace																■																			■	■
	Raufoss Technology																							■													
Spain	Alcatel Espacio			■	■									■			■																				■
	CASA																												■	■	■					■	
	Crisa		■	■	■	■				■									■			■				■										■	■
	Mier Comunicaciones													■																								
	Rymsa														■																							
	SENER		■			■											■					■						■									■	
Sweden	SAAB Ericsson Space		■	■	■	■								■	■																					■	
Switzerland	CIR		■	■	■	■													■			■															
	Oerlikon Contraves															■										■											■	
	Etel																																				■	■
	Mecanex																■																					■
United Kingdom	AEA Technology																	■																			■
	Com Dev Europe																																					
	Dowty																						■				■										
	EEV Ltd.									■	■					■										■												
	Marconi Avionics - Customer Support								■																													
	Royal Ordnance (ARC UK)																			■	■																
	Space Innovations Ltd. (SIL)	S	■	■						■	■	■		■	■			■	■																	■	■
	SIRA									■	■	■																									
	SSTL	S	■	■		■	■			■	■	■	■	■	■	■		■	■	■		■			■											■	
Canada	CAL Corp. (EMS Techn Canada Ltd)									■				■	■			■	■																		
	Com Dev Ltd														■			■																				
	SPAR Space (EMS Techn Canada Ltd)		■	■	■										■														■	■						■	

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Production Capabilities and Competencies of Satellite Equipment Suppliers in ESA's Member States and Canada

Effective production (95-98)

Production capability - no recent sales

Possible or anticipated future capability

Production/capability for equipment parts

S Companies working exclusively or quasi-exclusively on smallsats (<300kg)

Elements provided by the companies

			Telecommunications Equipment for payloads (Telecom & EO/Science)																						EO/ Science specific equipment											
			Acqu. Mgmt		Antennae							Transponders											Intersat links			EO & Meteo sensors					Data Acquisition & Management						
			Dedicated Computer	Payload Interface Unit (PIU)	Active Antenna	Passive Antenna (RF part)	Reflector < 3m	Reflector 3-6m	Reflector > 6 m	Deployment mechanisms	Pointing/Tracking mechanisms	TWT	Electric Power Conditioning	SSPA, incl. EPC	Channel amplifiers	Low noise amplifiers	Low noise receivers	Up/Down Converters	OBProcessor-Analogue	OBProcessor-Digital	OMUX/IMUX	Switches	RF Inter Satellite Links	Optical Inter Satellite Links	Other equipment	Optical/Optronic sensors	Radar sensors	Radiometers	Lidars	EO/ Scientific instruments	Signal Conditioning & Coding	Data compression & encryption	Data/ Image processing	Instrument Control Unit	Data handling	Mass memory	Other equipment
Austria	Austrian Aerospace																																		
Belgium	Alcatel ETCA																																		
	Alcatel Bell																																		
	Sabca																																		
	SONACA																																		
	VDD	S																																	
Denmark	Alcatel Denmark																																		
	Per Udsen Co.	S																																	
	Terma Elektronik AS																																		
Finland	Patria Finavitec																																		
	Ylinen Electrics Co.																																		
France	Dassault Aviation																																		
	Dassault Electronique																																		
	Pyroalliance																																		
	REOSC																																		
	SAFT																																		
	SAGEM SA																																		
	SEP - SNECMA Division																																		
	Sextant Avionique - ASPI Valence																																		
	Sodern																																		
	TTE																																		
Germany	ASE																																		
	Bosch Telekom																																		
	Carl Zeiss Oberkochen																																		
	Daimler Chrysler Jena-Optronik																																		
	FPM	S																																	
	Jenoptik L.O.S.																																		
	Kayser-Threde	S																																	
	Man Technologie (incl. Zeppelin)																																		
	OHB System	S																																	
	Teldix																																		
Ireland	Captec Ltd																																		
	Devtec																																		

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Production Capabilities and Competencies of Satellite Equipment Suppliers in ESA's Member States and Canada

Effective production (95-98)

Production capability - no recent sales

Possible or anticipated future capability

Production/capability for equipment parts

S Companies working exclusively or quasi-exclusively on smallsats (<300kg)

Elements provided by the companies

			Telecommunications Equipment for payloads (Telecom & EO/Science) - Cont'd																					**EO/ Science specific equipment** - Cont'd											
			Acqu. Mgmt		**Antennae**							**Transponders**										**Intersat links**			**EO & Meteo sensors**					**Data Acquisition & Management**						
			Dedicated Computer	Payload Interface Unit (PIU)	Active Antenna	Passive Antenna (RF part)	Reflector < 3m	Reflector 3-6m	Reflector > 6 m	Deployment mechanisms	Pointing/Tracking mechanisms	TWT	Electric Power Conditioning	SSPA, incl. EPC	Channel amplifiers	Low noise amplifiers	Low noise receivers	Up/Down Converters	OBProcessor-Analogue	OBProcessor-Digital	OMUX/IMUX	Switches	RF Inter Satellite Links	Optical Inter Satellite Links	**Other equipment**	Optical/Optronic sensors	Radar sensors	Radiometers	Lidars	**EO/ Scientific instruments**	Signal conditioning & Coding	Data compression & encryption	Data/ Image processing	Instrument Control Units	Data handling	Mass memory	**Other equipment**
Italy	Carlo Gavazzi Space	**S**																																
	FIAR																																	
	Fiat Avio																																	
	Laben																																	
	Oerlikon Contraves SpA	**S**																																
	Officine Galileo																																	
Netherlands	Bradford Engineering																																	
	Fokker Space																																	
Norway	AME Space																																	
	Kongsberg Defence & Aerospace																																	
	Raufoss Technology																																	
Spain	Alcatel Espacio																																	
	CASA																																	
	Crisa																																	
	Mier Comunicaciones																																	
	Rymsa																																	
	SENER																																	
Sweden	SAAB Ericsson Space																																	
Switzerland	CIR																																	
	Oerlikon Contraves																																	
	Etel																																	
	Mecanex																																	
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Canada	CAL Corp. (EMS Techn Canada Ltd)																																	
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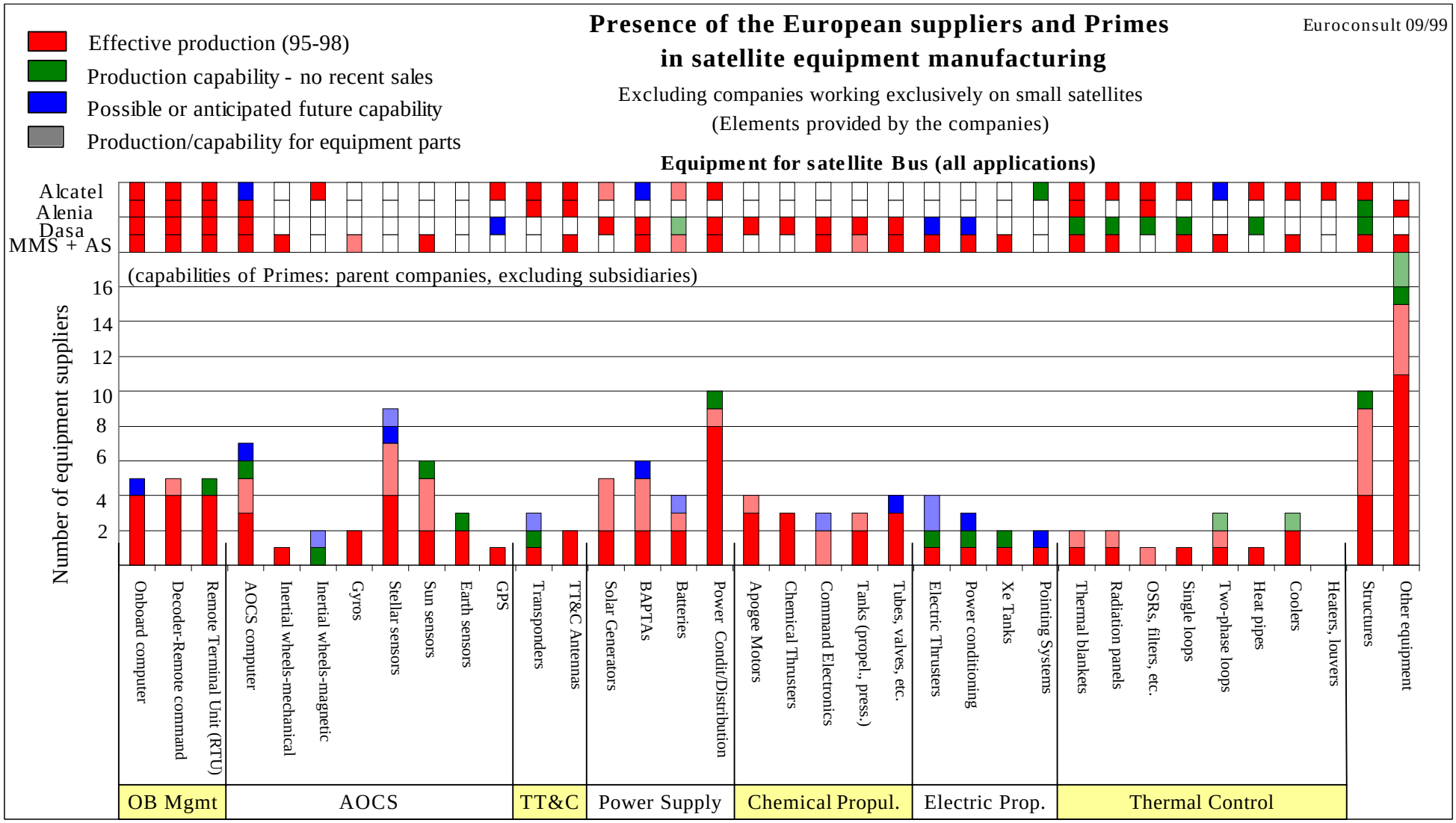
Effective production (95-98)
Production capability - no recent sales
Possible or anticipated future capability
Production/capability for equipment parts
Presence of the European suppliers and Primes in satellite equipment manufacturing
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Excluding companies working exclusively on small satellites
(Elements provided by the companies)
Equipment for satellite Bus (all applications)
Alcatel
Alenia
Dasa
MMS + AS
(capabilities of Primes: parent companies, excluding subsidiaries)
Number of equipment suppliers
16
14
12
10
8
6
4
2
Onboard computer
Decoder-Remote command
Remote Terminal Unit (RTU)
AOCS computer
Inertial wheels-mechanical
Inertial wheels-magnetic
Gyros
Stellar sensors
Sun sensors
Earth sensors
GPS
Transponders
TT&C Antennas
Solar Generators
BAPTAs
Batteries
Power Condit/Distribution
Apogee Motors
Chemical Thrusters
Command Electronics
Tanks (propel., press.)
Tubes, valves, etc.
Electric Thrusters
Power conditioning
Xe Tanks
Pointing Systems
Thermal blankets
Radiation panels
OSRs, filters, etc.
Single loops
Two-phase loops
Heat pipes
Coolers
Heaters, louvers
Structures
Other equipment
OB Mgmt
AOCS
TT&C
Power Supply
Chemical Propul.
Electric Prop.
Thermal Control

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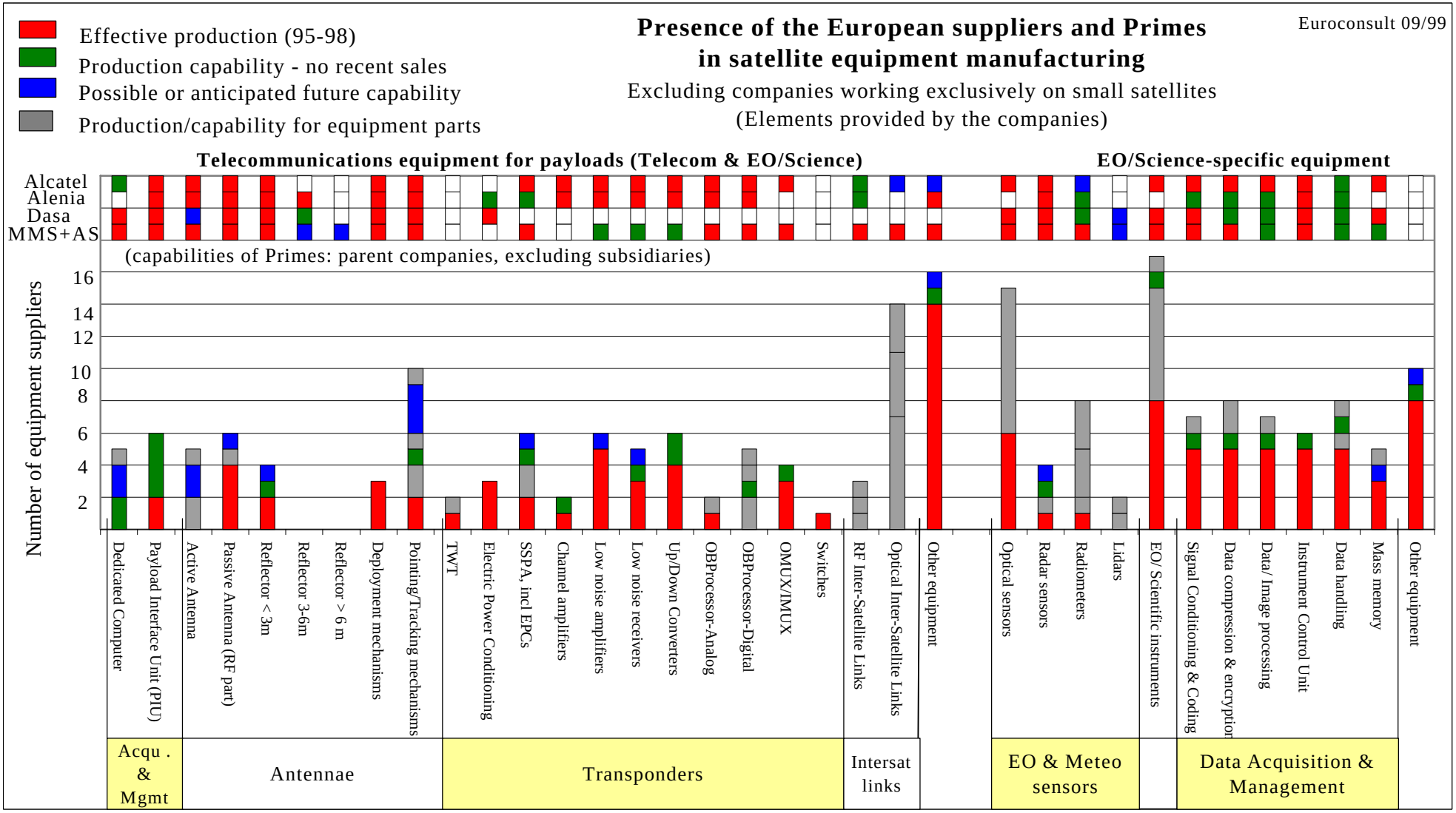
Presence of the European suppliers and Primes in satellite equipment manufacturing

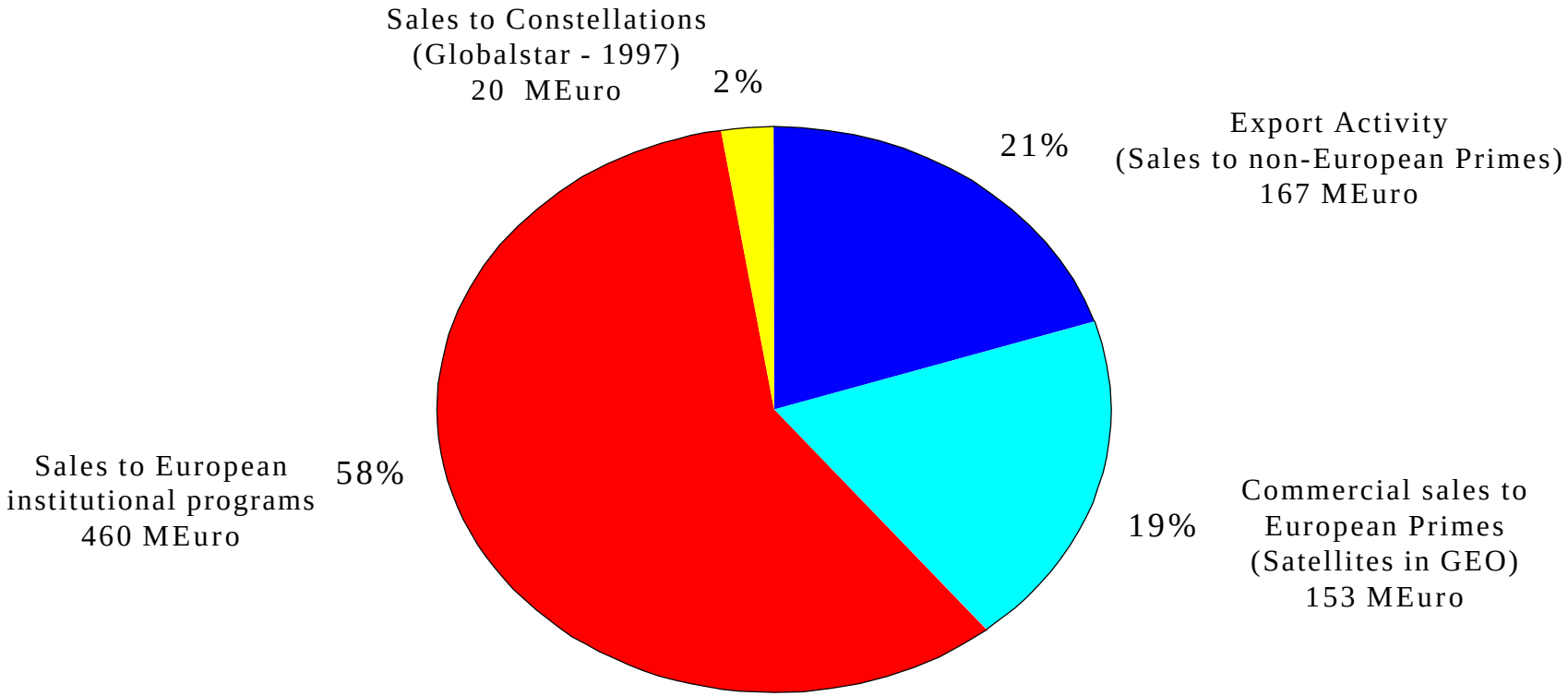
Excluding companies working exclusively on small satellites
(Elements provided by the companies)



The Satellite Equipment Business of Suppliers in ESA Member States (excluding Primes)

Average annual values (Euro in millions), 1995-1997
(Only hardware manufacturing is considered, excluding AIT, Software, etc.)
Elements provided by the companies surveyed
They represent 95-98% of the total satellite equipment supply activity in ESA Member States

Total: 800 MEuro



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the European commercial market. Their products concern standard equipment for telecommunications payloads, used in great number, or often specific and expensive standard equipment for the satellite bus.

In terms of size, 13 companies show annual satellite equipment sales higher than 20 MEuro and they are responsible for the best share of all types of markets (see figures): 63% of sales to European institutional programmes, 74% of total commercial sales, and 77% of sales to non-European Primes (export activity). The five largest suppliers among them (> 50 Meuro) are, in alphabetical order: Bosch Telekom, Fokker Space, Laben, Saab Ericsson Space and Thomson Tubes Electroniques-TTE, while the next 8 are (again in alphabetical order): Alcatel ETCA, Alcatel Espacio, CASA, Oerlikon Contraves (now Contraves Space AG), Officine Galileo, SEP, Sextant (before its merging with Alcatel Space Industries in 1998), Sodern.

Among these 13 suppliers, the least dependent on ESA R&D support and ESA programmes, are found in France and Germany, countries with the strongest presence of Primes: Bosch Telekom, TTE, SEP, Sodern, and ex-Sextant. Their self-funded R&D efforts are generally high, and are usually complemented by National Agencies. The first two suppliers are the two European leaders in commercial sales and exports, while the other three have some commercial presence but mainly work on national institutional programmes. They are all enjoying high overall internal synergy, even though this may not be directly related to equipment production.

The 8 remaining suppliers belong to other countries: Italy (Laben, Officine Galileo); Spain (CASA, Alcatel Espacio); Sweden (Saab Ericsson Space); Switzerland (Oerlikon Contraves); the Netherlands (Fokker Space); and Belgium (Alcatel ETCA), and depend on ESA programmes for the majority of their satellite equipment activity, while ESA R&D support is almost always their major funding source. Their commercial record varies, and for five of them (Saab Ericsson, Fokker, Alcatel ETCA, Alcatel Espacio, Officine Galileo) it is significant (25% to 50% of total sales). Laben and Fokker are big companies specialised in the satellite business, while the other six suppliers have relatively high degrees of internal synergy with the rest of the company.

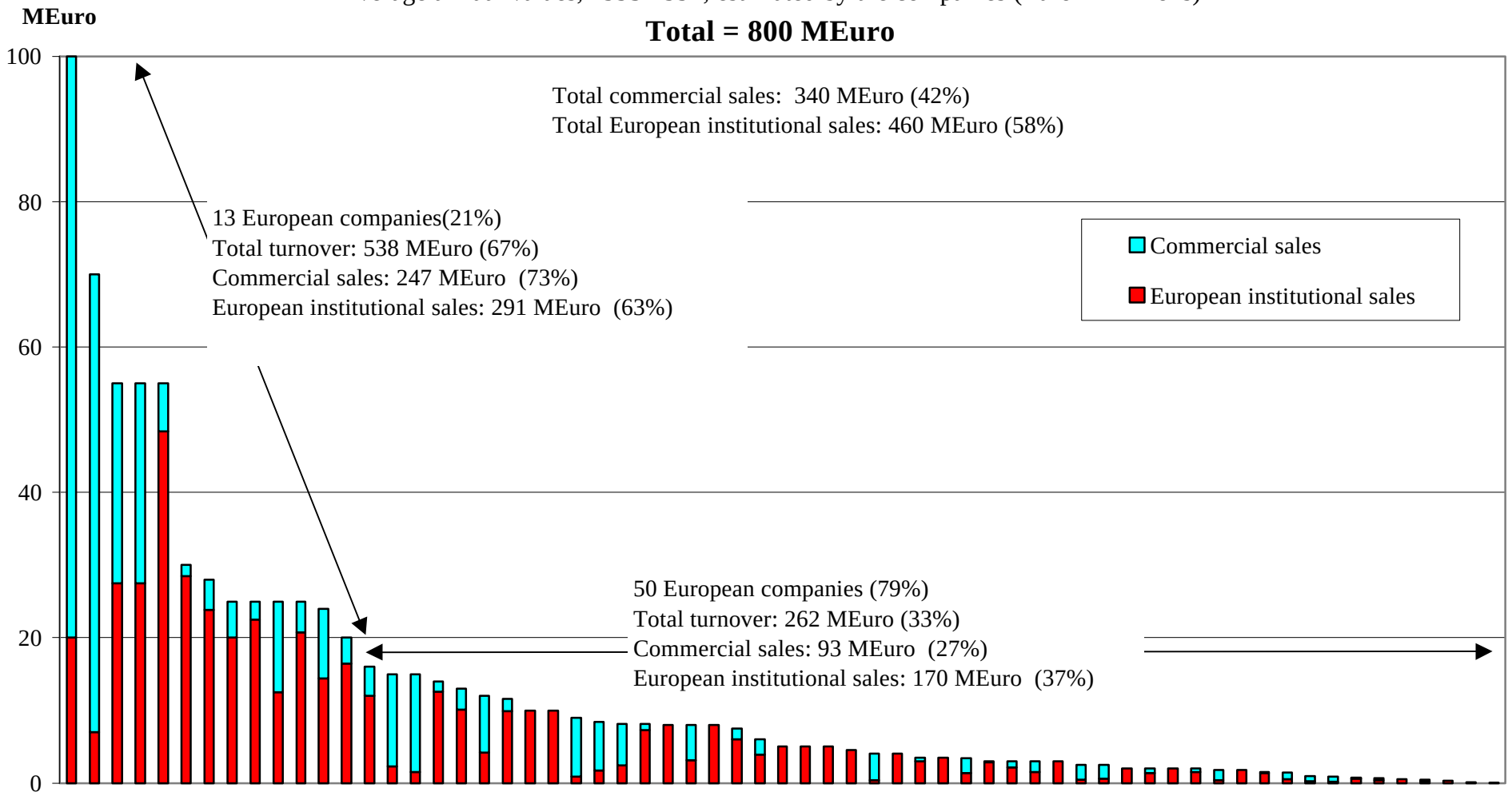
For both groups of companies, the ESA and National Agencies, through their programmes and R&D support, constitute the main drivers of their activity and growth, with the exception of Bosch Telekom and TTE, which produce standard equipment for telecommunications payloads and rely much less on institutional markets.

More than half of equipment sales (57%) are made by suppliers from just three countries (France, Germany, and Italy), the same countries where the large European prime contractors are located (see figures). This share rises to two-thirds of total (66%) if one adds Spain. Commercial performance does not follow exactly the same pattern. Germany (due mainly to Bosch, ASE and Teldix), and France (due mainly to TTE and SAFT), occupy the first two positions (excluding Canada), accounting for about 200 MEuro, or 58% of total European commercial sales (340 MEuro). However, Italy and Spain are under-performers, selling about 80% of their production to institutional programmes. They are out-distanced in terms of commercial sales by Sweden and the Netherlands, mainly thanks to Saab and Fokker, respectively. If one takes into account the commercial share in the total turnover, more countries have superior performance: the United Kingdom, Belgium, Denmark, and Norway, mainly due to Dowty, Royal Ordnance (now ARC UK Ltd.), GEC-Marconi Avionics, and Alcatel’s subsidiary companies in Belgium, Denmark, and Norway).

The majority of commercial sales outside Europe (export to non-European Primes) are handled by France and Germany (113 MEuro, or 68% of a total of 167 MEuro), mostly due to TTE, Bosch Telekom and Teldix' activity. Since exports constitute one part of the commercial sales examined above, the rest of the export activity (54 MEuro) is carried out by most of the same countries and companies: Sweden, the Netherlands, the United Kingdom, Denmark, and Norway. Practically no export activity took place during the 1995-97 period in Italy, Spain, Switzerland, Belgium, Austria,

European Satellite Equipment Suppliers: Commercial versus European Institutional Sales

Average annual values, 1995-1997, estimated by the companies (Euro in millions)



63 European Satellite Equipment Suppliers surveyed

These companies represent 95-98% of the total satellite equipment activity in the 14 ESA Member States

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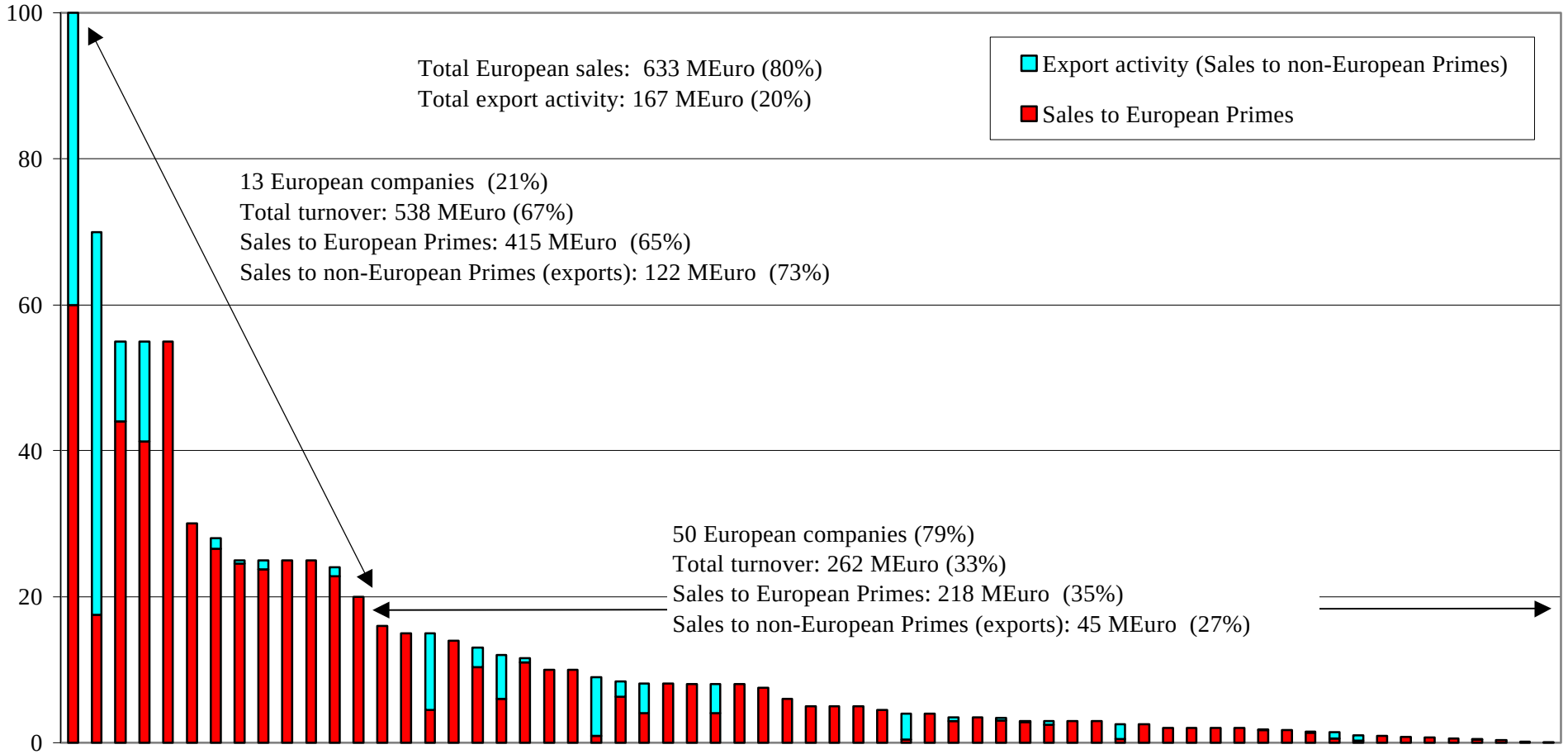
European Satellite Equipment Suppliers: European versus Export Sales

Average annual values, 1995-1997, estimated by the companies (Euro in millions)

Total = 800 MEuro



63 European Satellite Equipment Suppliers surveyed

These companies represent 95-98% of the total satellite equipment activity in the 14 ESA Member States

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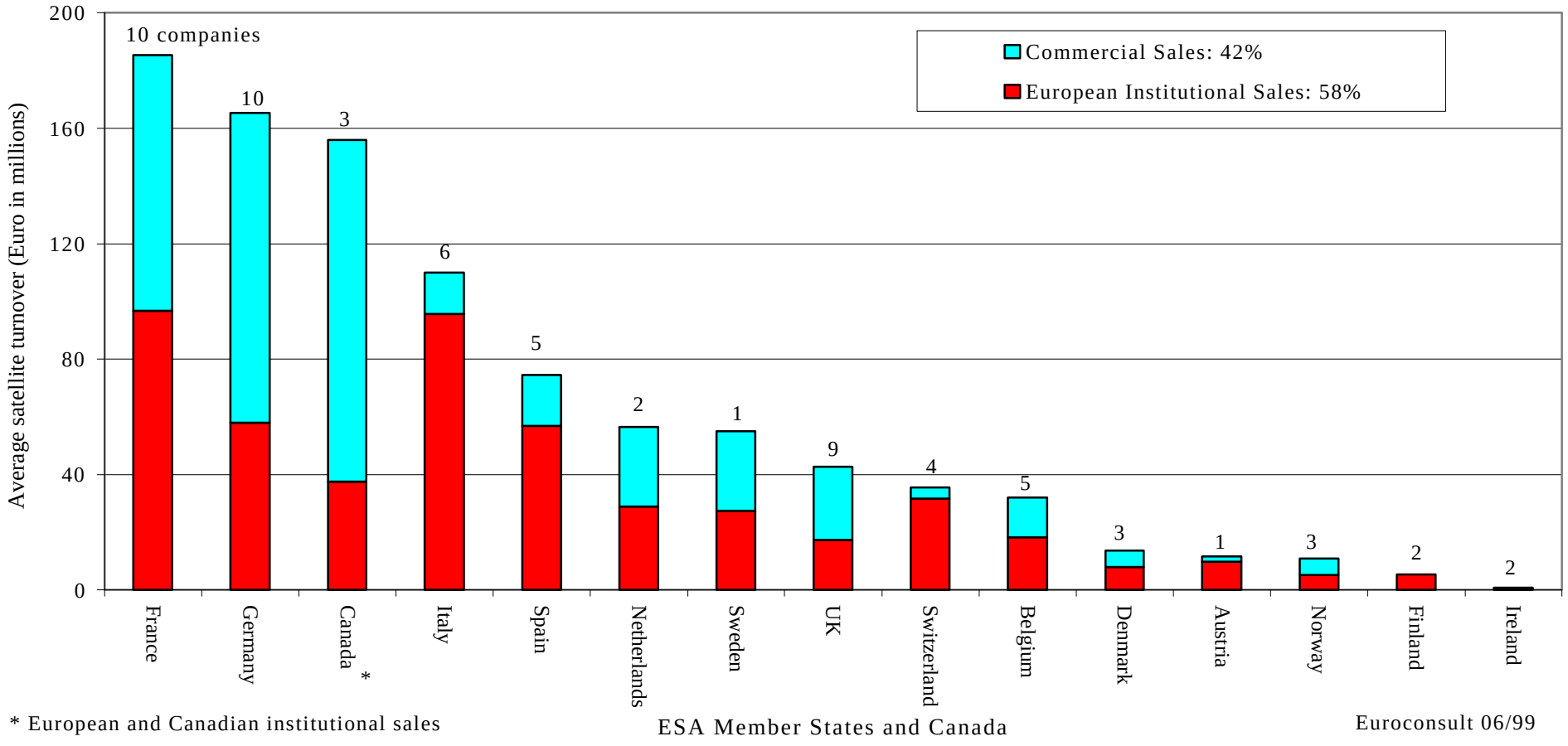
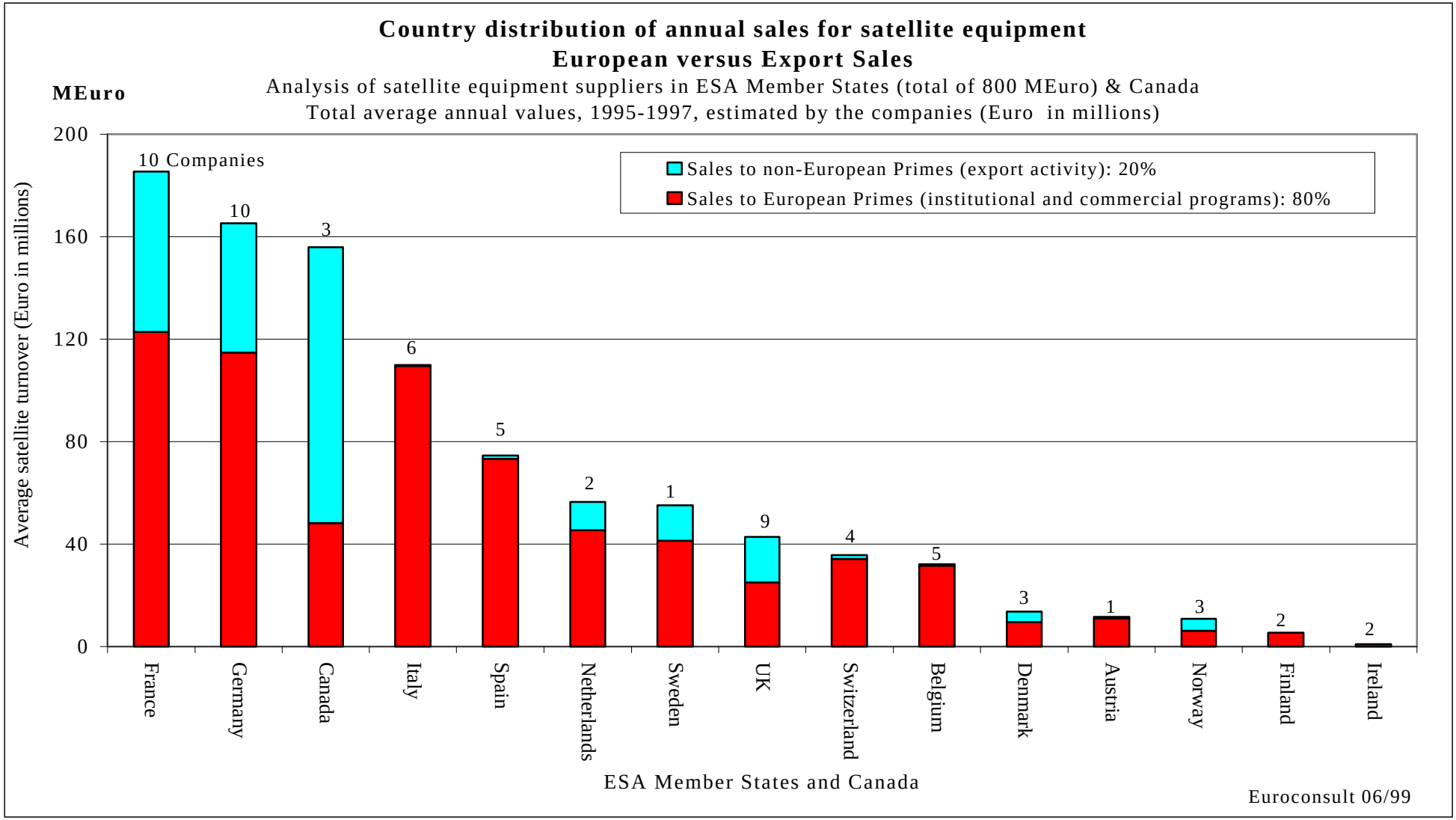
Country distribution of annual sales for satellite equipment

Commercial versus Institutional Sales

Analysis of satellite equipment suppliers in ESA Member States (total of 800 MEuro) & Canada
Average annual values, 1995-1997, estimated by the companies (Euro in millions)




Country distribution of annual sales for satellite equipment
European versus Export Sales
Analysis of satellite equipment suppliers in ESA Member States (total of 800 MEuro) & Canada
Total average annual values, 1995-1997, estimated by the companies (Euro in millions)
MEuro
Average satellite turnover (Euro in millions)
200
160
120
80
40
0
Sales to non-European Primes (export activity): 20%
Sales to European Primes (institutional and commercial programs): 80%
10 Companies
10
3
6
5
2
1
9
4
5
3
1
3
2
2
France
Germany
Canada
Italy
Spain
Netherlands
Sweden
UK
Switzerland
Belgium
Denmark
Austria
Norway
Finland
Ireland
ESA Member States and Canada
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Finland, and Ireland.

Thus, there is a great diversity among companies and among countries in terms of total satellite equipment sales and relative performance in their commercial markets, illustrating the overall European diversity from several points of view (heritage and time of arrival in the satellite business, importance of industrial players, tradition in targeting commercial markets, etc.).

It appears though that some basic characteristics are common to companies who have more success than others in commercial markets, a key result of competitiveness. They are all involved in the manufacturing of rather standard equipment, highly specialised, bringing a particular added value to clients, who are often either not present, or not self-sufficient in that equipment: RF equipment from Bosch and TTE, responsible for the lion's share of commercial and export sales; smaller or lower-level RF equipment, mainly from Alcatel's subsidiaries; chemical propulsion standard equipment (fuel tanks, thrusters, and Apogee Booster Motors); mechanical inertial wheels; gyros; solar cells and panels; and batteries. More companies supply equipment to commercial markets, including some exports, and they have lower sales volumes, of the order of a few hundred to a few million Euro (some AOCS sensors sold by a few specialist companies, electric motors, slip rings, small hydraulic equipment, and parts of RF equipment sold by suppliers who are not Prime subsidiaries).

Satellite equipment activity in the three Canadian companies surveyed constitutes a particular case and it should not be statistically combined with that of European suppliers. In fact, following their own heritage, evolution and geographic situation, they all work heavily with US prime contractors, supplying standard products mainly for telecommunications payloads. Two of these suppliers, CAL Corp., already owned by the US company EMS Inc., and Spar Space Systems, recently acquired by EMS Inc., now constitute EMS Technologies Canada Ltd. (Ottawa and Montreal sites respectively), while Com Dev is one of the major telecommunications equipment suppliers in North America.

High specialisation of small-turnover suppliers, heavily present in institutional markets

The average size of the satellite business in the companies surveyed (about 12 MEuro) drops down to about 2.5 MEuro for the group of 32 companies who show annual sales of less than 5 MEuro. Independent of the size of equipment turnover, half of the total population of companies is specialised in the satellite field (>80% of their space sales). Furthermore, half of the companies (not the same as the ones above) depend almost entirely on institutional sales (>80%), while the rest of them are rather evenly spread between high involvement in institutional programmes and good performance in commercial markets. The vast majority of suppliers (39) have no sales outside Europe, while for 8 more companies this performance stays under 10%.

Share of marketing efforts for commercial programmes increases and seems to be effective

Equipment suppliers are looking increasingly to commercial markets as a source of revenue, since current sales to commercial programmes are relatively low, and concentrate increasing marketing efforts in their plans. Effectiveness of these efforts can already be observed for about 25 companies, since commercial sales grow proportionally. For the rest of the suppliers, heavily dependent on sales to European institutional programmes, such marketing efforts are still either weak and/or quite recent, not having had the time to produce full or significant results.

A big group of companies specialising in small satellites (<300 kg)

Nine companies were identified as working exclusively in this business. For five of them (SSTL, SIL, OHB System, Carlo Gavazzi, Kayser Threde, and newcomer VDD), though, the primary role is not really seen as the manufacturing of satellite equipment proposed to several clients. These companies are rather inceptors, manufacturers, and responsible for entire small satellites, playing the role of prime contractors in this business. Total average annual sales for satellite equipment manufactured by

these companies has been about 20 MEuro (1995-97) for a wide range of adapted equipment, going from mass memories for onboard computers, to stellar and GPS sensors.

A more important aspect of this market could be technological, since most of the equipment flown on board these satellites contains a great deal of innovative solutions in terms of miniaturisation, efficiency, use of non space-specific equipment, etc. The European leaders are SSTL of the UK, and OHB System of Germany (who owns Carlo Gavazzi of Italy), both being presently responsible for satellites at the upper end of the small-satellite mass range. The world-wide competition is very strong, due to the low barrier of entry, including institutes and universities which allow countries with no space heritage to enter the field.

2.3 Sizeable overall European R&D efforts are implemented

Annual R&D efforts in European countries (excluding Canada) amount to 131 MEuro, or 16% of total sales (800 MEuro), with ESA funding of 47 MEuro/year and self-funding of 46 MEuro/year being the first two funding sources (36% of total R&D or 6% of total sales for each one of them). The shares of the other funding sources are: National Agencies (27 MEuro/year or 20%), and prime contractors (10 MEuro/year or 8%). Funding comes from specific R&D programmes, but also from development carried out within institutional missions, for work considered by the companies as R&D. All external sources of R&D support (84 MEuro/year, or about 10% of total turnover) are invoiced by the companies and thus constitute part of their satellite equipment turnover.

R&D needs during the next five years are expected to be on the average 20% higher than past R&D financing (about 157 MEuro/year versus 131 MEuro/year), and even 26% if one includes the three Canadian companies (about 190 MEuro/year, versus 150 MEuro/year for the two periods examined). These needs do not accurately represent R&D plans made by the companies. They are, rather, an assessment of the most probable requirements, under the assumption of existing external support, in order for the suppliers to both improve current technologies and products.

Diversity in the size, funding sources, and effectiveness of countries' R&D efforts

R&D efforts in some European countries follow a pattern consistent with their relative performance in equipment sales. If one excludes Canada, the third biggest R&D spender, Germany, France, and Italy are the countries with the highest R&D efforts, in accordance with their highest equipment sales we saw earlier. Particularly low ESA funding observed for France and Germany, combined with high self-funding efforts to fill the gap, could be related statistically to the highest European shares of commercial and export sales enjoyed by these two countries.

A few companies are undertaking most of the R&D work

Average R&D spending per company was about 2 MEuro/year (1993-97), but it conceals large differences, as was the case with the size of sales:

- The 7 biggest European R&D spenders (>5 MEuro/year) amount to 60 MEuro (8.5 MEuro/year/company, or 46% of total European efforts;
- Another 13 European companies have annual R&D spending between 2 and 5 MEuro (about 3 MEuro on the average) and account together for 38 MEuro, or 29% of total European.
- The vast majority of suppliers (43 out of 63 European companies or 68%), though, show R&D annual spending of less than 2 MEuro (0.75 MEuro/company on the average), in accordance with the existing large numbers of low-sales suppliers.

Self-funded R&D seems efficient for commercial sales

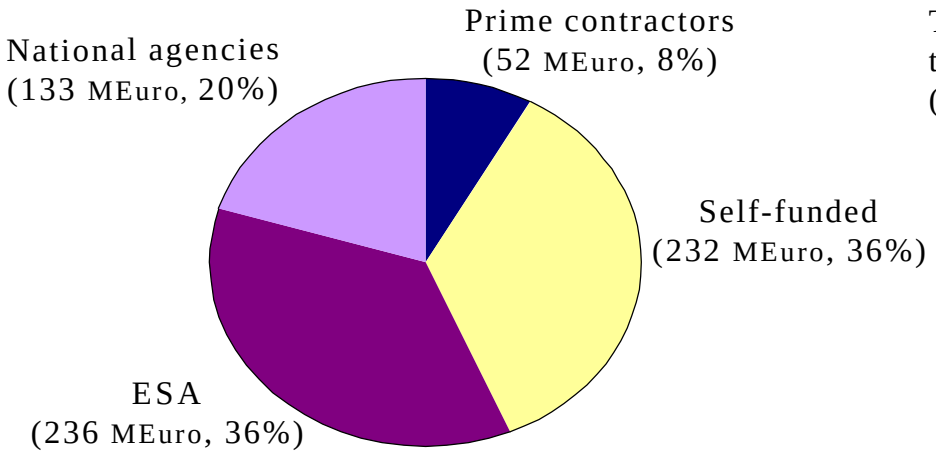
Self-funded R&D is most of the time spent with commercial success in mind, and this clearly

European Equipment Suppliers

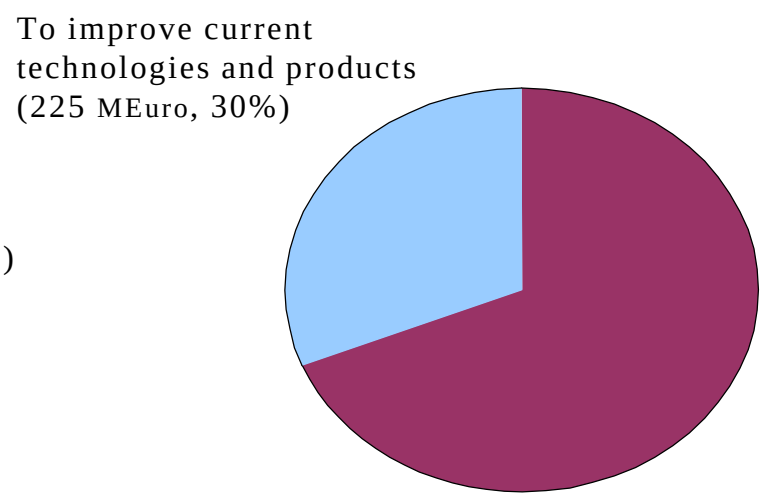
Total R&D efforts for satellite equipment and funding sources

Average values during 5 years (1993-1997), provided by the companies
Theoretical future R&D needs during the next five years (independent of the availability of funds), estimated by the companies
All 63 companies surveyed in ESA Member States
(same scale used as with the presentation of European Primes' R&D)

Past 5-year efforts
Total= 653 MEuro



R&D needs during the next five years
Total= 785 MEuro



Annual R&D : **131 MEuro**
16% of satellite equipment activity turnover (**800 MEuro**)

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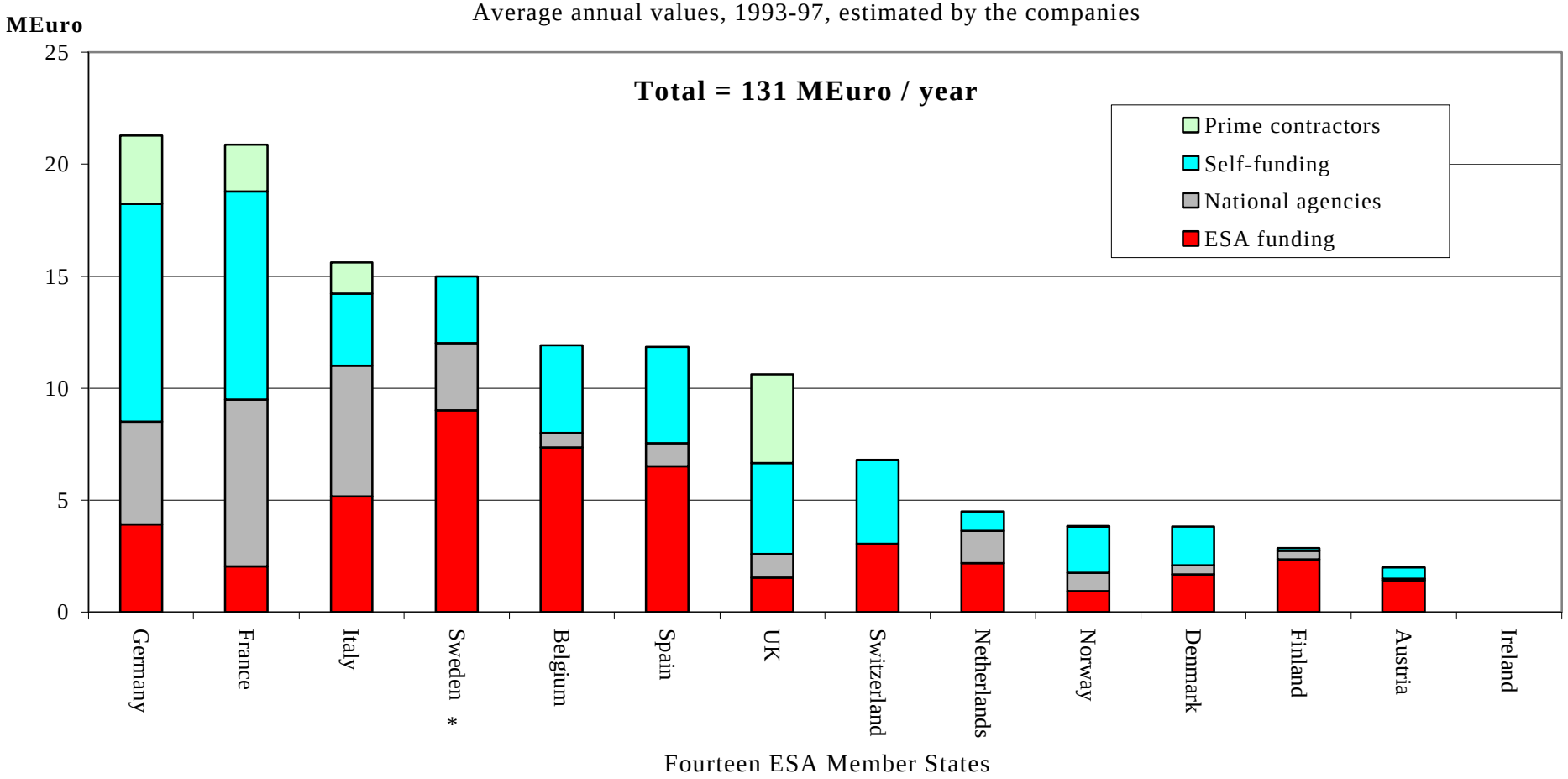
Average annual R&D funding for satellite equipment during five years (1993-97)

Analysis of satellite equipment suppliers in ESA Member States, excluding Prime contractors

Average annual values, 1993-97, estimated by the companies



*Includes a large part of non-specifically R&D activity in ESA programmes

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visible in the impact it has on commercial sales for more than half of the companies. About 15 to 20 more companies have low or no return on self-funded R&D work, and it indicates such recent efforts by rather low-sales suppliers. It appears statistically that suppliers who are subsidiaries or related to Prime groups show a higher efficiency in their self-funded spending.

ESA R&D support is unevenly distributed and often related to work for missions

ESA support is the largest R&D funding source for European companies (47 MEuro or 36% of a total of 131 MEuro) and it is spread unevenly among equipment suppliers. The 7 European companies indicated above, having the highest R&D spending in absolute terms, are absorbing 26 MEuro, or 55% of the ESA total R&D support. Sixteen companies receive no ESA support at all, while about half the companies receive a few hundred Euro each, independent of the percentage it represents to their total R&D spending. Most ESA R&D support, identified as such by suppliers, is related to specific work for missions rather than to non-recurrent activity for the development of products targeting commercial markets. Thus, by nature, the impact of this support is inversely proportional to the share commercial sales represent for these companies, since they are, rather, occupied with ESA-specific work.

2.4 European suppliers have a good potential to address today's challenges

We have seen that European satellite equipment suppliers are all of different origins and represent a wide spectrum of competencies and technological heritage, but also of business performance, constraints, and determination for growth. The structure of the European equipment industry was not deeply transformed during the last few years, but several signs of concentration are visible. Consolidation affecting the equipment industry is not always exclusively driven by satellite activity. Sagem recently acquired SFIM Industries (REOSC); Dassault Electronique is now part of Detexis, a new entity of Thomson; SEP became a division of SNECMA; Aerospatiale had acquired Sodern; MAN Technologie acquired Zeppelin; Terma Elektronik bought the software company CRI, previously owned by IBM, and more recently Per Udsen. After Teldix was acquired by Litton in 1996, the satellite activities of Royal Ordnance were acquired by its US competitor ARC, and Satellite Innovations Ltd of the UK (SIL) was acquired by Marotta.

European suppliers enjoy a wealth of synergy, according to their industrial heritage

The analysis has shown that a large part of Europe's strengths reside in the multiple competencies and technological skills found across the continent, related to markets as diverse as aircraft and launchers, but also land transport, consumer markets, etc, and often independent of each company's involvement in the satellite equipment business, or the degree of its commercial success so far.

Synergy and company's determination will be the key drivers for success

Synergy alone is not enough for the success of an equipment supplier. No general conclusions could thus be drawn for the relation between a company's competitiveness and the degree of synergy it enjoys, or the size of the parent company. It appears that synergy is important in several cases, but it has also been transformed into an overall European fragmentation. The determination of a company to conquer global market-shares would be the strongest driving force for success. This determination was identified during the survey in a great number of suppliers, present or not yet present in commercial markets.

3. Analysis of the European prime contractors

3.1 Emergence of two world-class European prime contractors

Over the past two years, European satellite prime contractors have begun merging in an attempt to reach a size comparable to that of the world leaders in commercial satellites, leading to the consolidation into 2 industrial groups, Alcatel Space Industries and Astrium.

Alcatel Space Industries, owned 51% by Alcatel and 49% by Thomson-CSF was formed on 1st July 1998. It includes practically all the satellite activities of Aerospatiale.

The **Astrium** group is being formed gradually. The MMS-DASA merger should be followed by the merging of Alenia Spazio, while the merger between Matra Hautes Technologies and Aerospatiale already took place in 1999, and some of the remaining satellite equipment activities at the Les Mureaux and Acquitaine sites are now part of the group. CASA of Spain will most likely join the Astrium group, too.

The two groups will try to strengthen their position, mainly by improving their competitiveness for a larger world market-share and by securing a significant share in institutional (ESA and national agencies) programmes and R&D support.

- The competitiveness will be strengthened through a consolidation and rationalisation of the business carried out by each entity within the group (both the parent company and entities controlled by, or related to, them throughout Europe), followed by a more systematic application than previously of the "buy-or-make" policy, similar to the strategy of US Primes;
- Significant participation in institutional programmes will be secured by the physical presence of subsidiaries in nine (9) ESA Member States (ASPI's subsidiaries throughout Europe and those of Astrium's four-nation venture);
- R&D support from institutional sources will, of course, be a priority for prime groups, in order to lower the recurrent cost of key, but expensive to develop, future products. According to the Primes' estimates (see figure), their total future needs would be of the order of 100 MEuro / year (up 20% from past R&D expenses). Experience during the last 5 years shows that over 50% of R&D efforts are funded by national agencies and ESA.

3.2 The main objective pursued by the prime contractors is competitiveness

World competition for European prime contractors is fierce and it obliges them to achieve the same or better levels of performance as their competitors in terms of delivery times, price, technological performance, reliability, and even financial flexibility with the client. This task is particularly difficult for European Primes that compete against the most powerful US Primes. These US Primes have benefited from a much larger domestic captive market, large R&D support from ambitious institutional (civil and military programmes) during the last 30 years, a stronghold on the world's commercial markets, and an earlier propensity for initiating multi-billion dollar satellite systems.

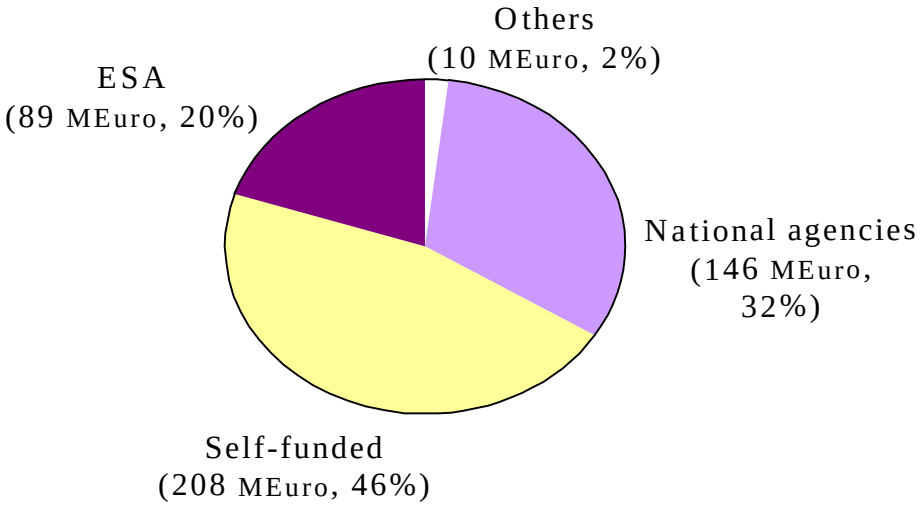
- **reduction of delivery times** is a real challenge, the current target being 18 months or less for a satellite in GEO. The entire production process has to be optimised and in-depth knowledge of satellite/equipment interfaces is a fundamental issue for Primes. This favours self-procurement, resulting in a higher integration level and shorter delivery times, as well as external procurement for standard, competitive, and proven equipment. The mass production for constellations makes it more challenging and favours the procurement of 'off-the-shelf' products, discouraging Primes' self-procurement for some equipment;
- **decrease in satellite prices** for given equipment performance is continuous and constellations are accelerating this trend by introducing new and leaner manufacturing procedures for big satellites. Procurement of standard, 'off-the-shelf', proven equipment is thus favoured;

European Primes

Total R&D efforts for satellite equipment and funding sources

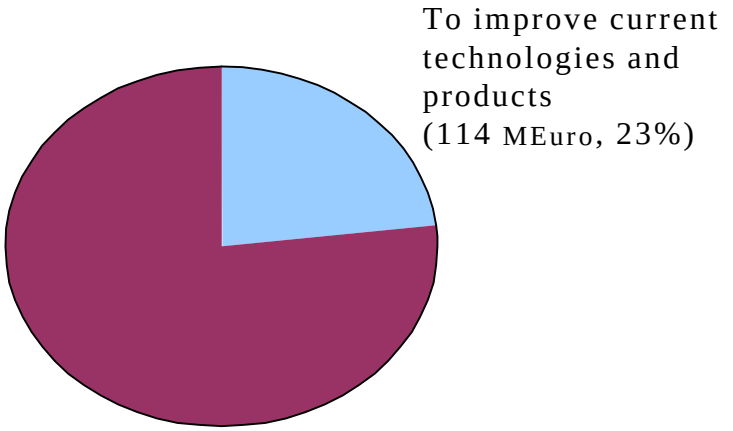
Average values during 5 years (1993-1997), provided by the companies
Theoretical future R&D needs during the next five years (independently of the availability of funds)
estimated by Alcatel Space Industries, Alenia Spazio, DASA/Dornier, MMS
(same scale used as with the presentation of the European suppliers' R&D)

Past 5-year efforts
Total= 425 MEuro



Annual R&D : **85 MEuro**
13% of satellite equipment activity turnover (**640 MEuro**)

R&D needs during the next five years
Total= 498 MEuro



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- **high performance and reliability** of satellites is another strong challenge for European Primes. Internationally they have a good record, but client needs and technology are evolving so rapidly that new requirements continually come to light (Ka-band satellites, inter-satellite links, high-power satellites, electric propulsion, onboard processing, higher integration, etc.). Primes thus prefer to keep control of all technologies considered strategic in order to maintain market position and anticipate future requirements, as well as to interface efficiently with their equipment suppliers.

3.3 Primes indicate an important fragmentation of the European equipment industry, strong technological skills, and overall weak preparation in the face of world competition.

European Primes believe that institutional programmes were at the origin of important technological developments and allowed many equipment suppliers to achieve the technological level of US competitors. However, these programmes also greatly contributed to an excessive fragmentation of the equipment industry, mainly due to the geographic return policy that ESA followed, in order to accomplished its important pan-European missions. Despite their specialisation, most suppliers lack the ability to propose competitive equipment to the world market, since they have no significant experience with commercial markets. There is no transformation of prototype work, carried out in an institutional programme, into commercial products.
Prime contractors will search for strong added value when procuring from equipment suppliers and, according to them, the key requirements for companies to become genuine equipment supplier are:

- to have very specialised skills and a continuous flow of innovations, necessary in this high-technology sector;
- to have a strong commitment to technology and to control it perfectly;
- to bring a specific added value to prime contractors who recognise it as such;
- to excel in all fundamental criteria: delivery times, price, and quality;
- to supply several Primes to attain serial production;
- to adopt a proactive commercial attitude.

3.4 The satellite industry will be organised around the vertical integration of Primes

The combined capabilities of Primes' parent companies are sufficient to produce the majority of equipment, with a few exceptions, mainly concerning AOCS sensors, equipment of the propulsion system for Alcatel, large reflectors, switches, and a few more for one or the other of the two groups. When the capabilities of suppliers owned by or related to Primes are added (e.g., subsidiaries of Alcatel Space Industries, as well as SAFT and TTE, or companies indirectly related to Astrium, such as Officine Galileo, Laben, FIAR, etc.), not much room is left for the procurement of entire equipment from other suppliers, especially the ones who have not yet created a stronghold in a competitive niche. A great concern can thus be identified in equipment suppliers not belonging to either of the two prime groups.

During the last few years (1995-1997), the value added in commercial GEO satellite equipment hardware manufactured by MMS, Aerospatiale-Cannes (now Alcatel-Cannes) and Alcatel-Toulouse was not impressive (20 to 30% of the hardware, on top of the added value for satellite integration and testing). During the same time, DASA, Dornier, and Alenia Spazio were playing the role of sub-system contractors and essentially the role of the most important European equipment suppliers, also responsible for most commercial sales to non-European customers and a large part of the Globalstar work.

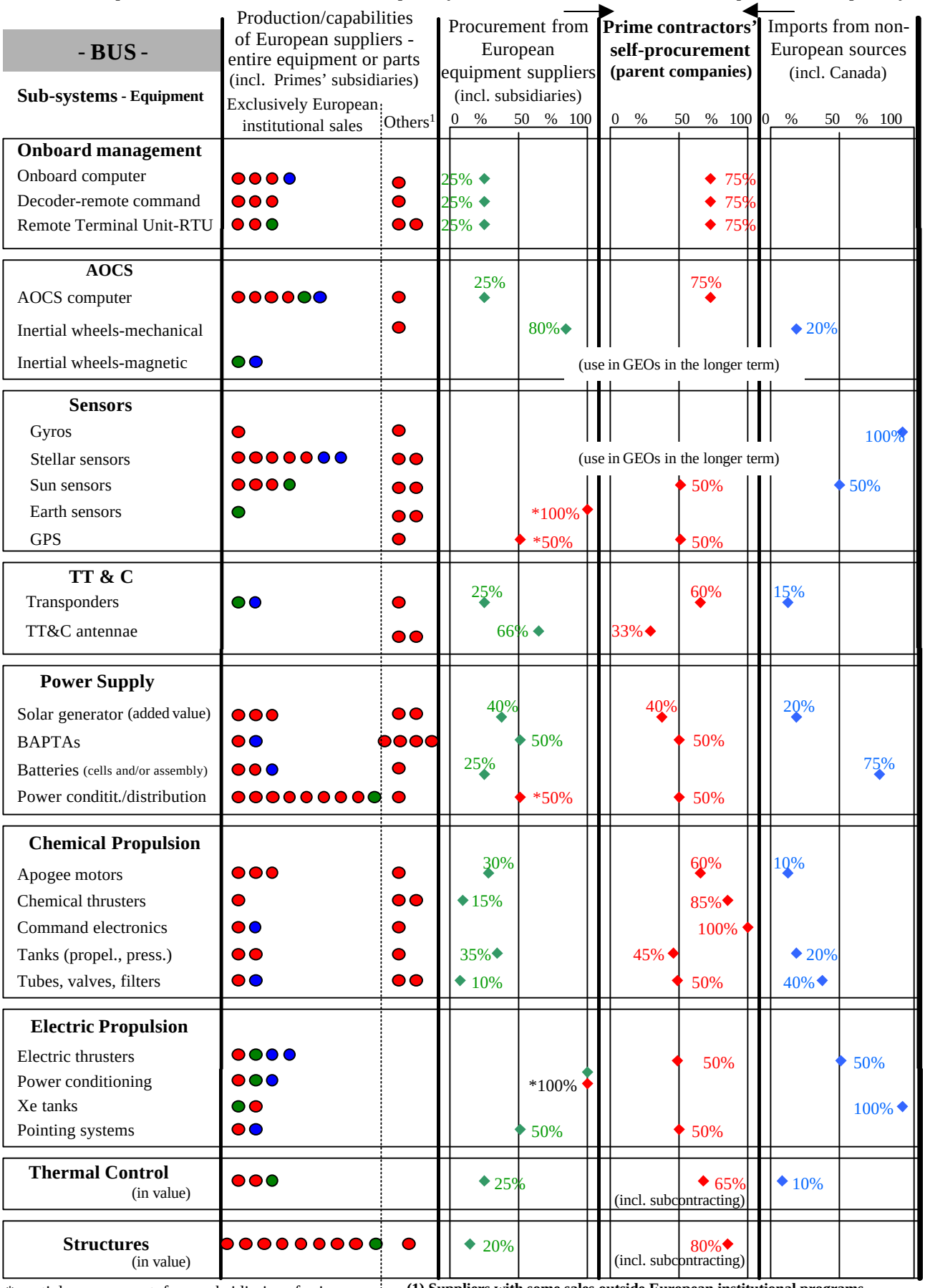
According to the new industrial structure, the parent companies of prime contractors, combined, manufactured about 50% of the satellite equipment added value for **commercial programmes** in

Procurement for commercial telecommunication satellites in GEO

Consolidation of estimates provided by European Prime contractors.

Approximate distribution of procurement sources in recent past and likely distribution in the very near future.

● Effective production 95-98 ● Production capability-no recent sales ● Possible/anticipated future capability



* partial procurement from subsidiaries of prime groups

(1) Suppliers with some sales outside European institutional programs

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Integration Level of European Primes and Presence of Equipment Suppliers

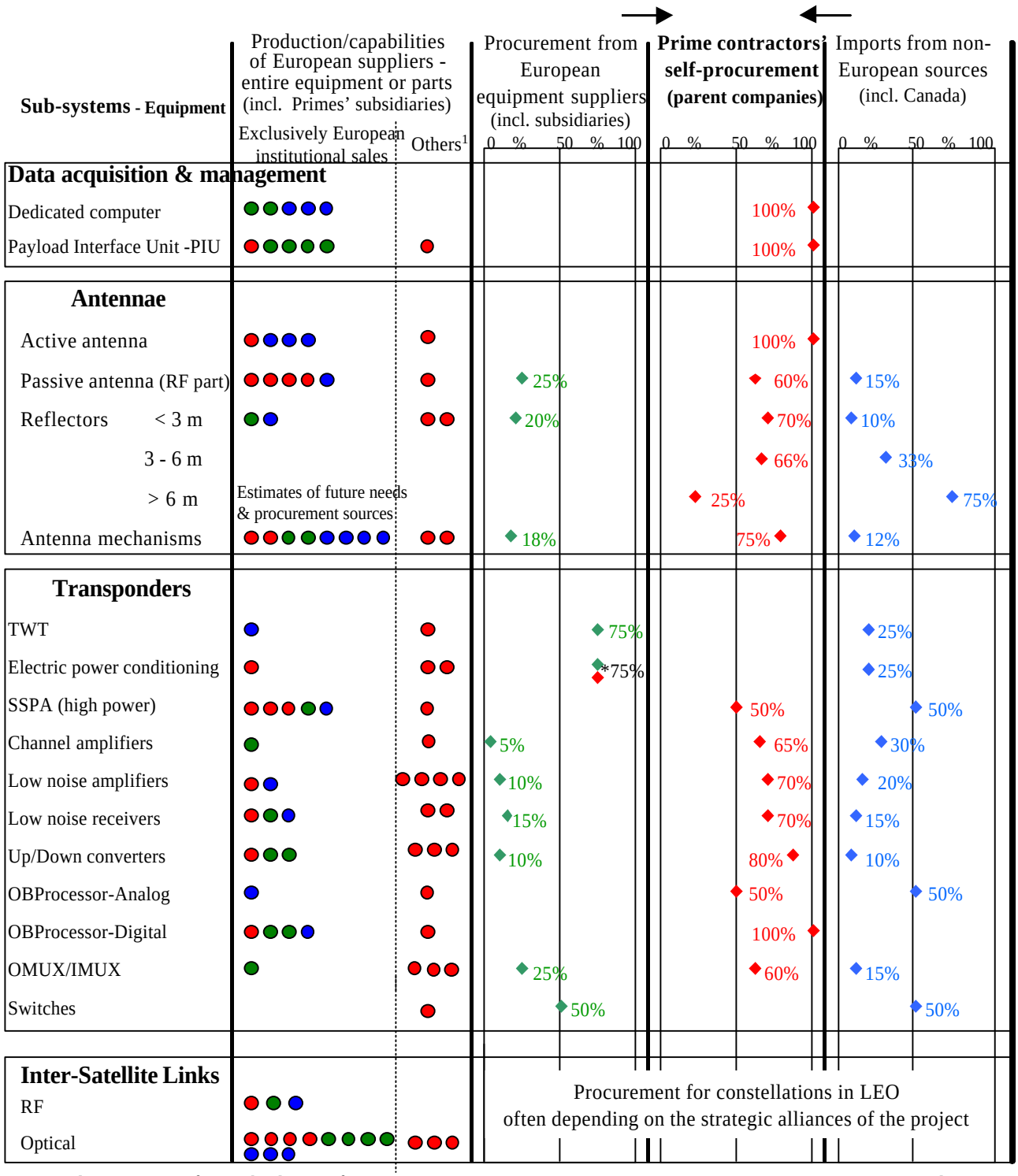
Procurement for commercial telecommunication satellites in GEO

Consolidation of estimates provided by European Prime contractors.

Approximate distribution of procurement sources in recent past and likely distribution in the very near future.

● Effective production 95-98 ● Production capability-no recent sales ● Possible/anticipated future capability

- Telecommunications PAYLOADS -



* partial procurement from subsidiaries of prime groups

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(1) Suppliers with some sales outside European institutional programs

GEO (an average of 220 MEuro/year out of a total of 443 MEuro/year in 1995-97) (see figure). Their subsidiaries also contributed for an additional 64 MEuro/year, resulting in a total "group" self-procurement of about two-thirds of the total satellite equipment value.

Parent companies also had a sizeable export activity of 80 MEuro at the equipment level for satellites in GEO (especially ASPI-Toulouse, Alenia Spazio, and Dornier), which corresponds to almost half the export activity achieved by equipment suppliers during the same time period (167 MEuro/year). Lastly, they have been the quasi-exclusive contributors to the European share of the Globalstar work at the equipment level for an estimated value of about 200 MEuro/year in 1997-98, in addition to their work in the integration and testing of those satellites.

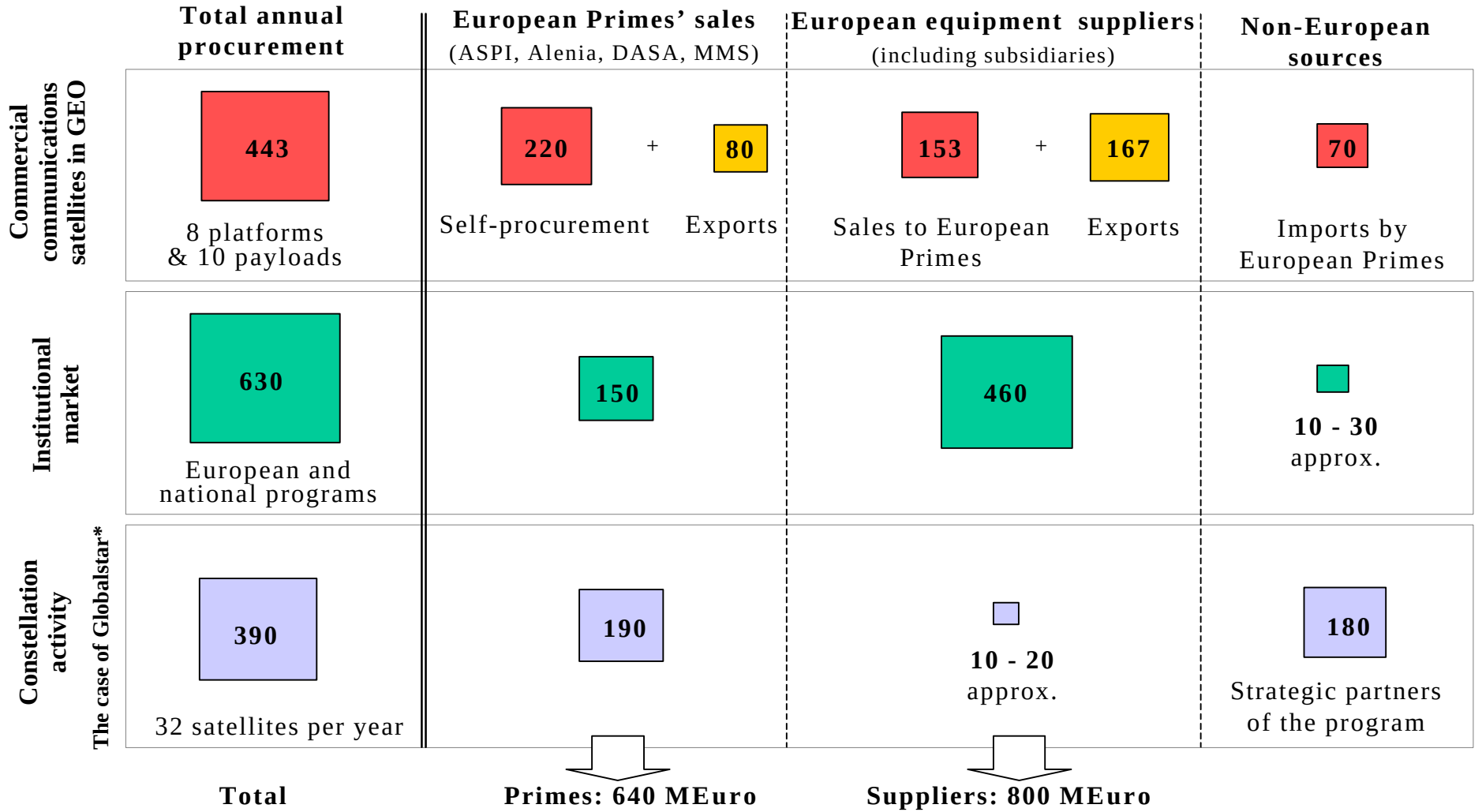
For **institutional programmes**, both European and national, the satellite equipment activity of prime contractors is quite low (one fourth of total, or 150 MEuro out of 610 MEuro), due to the major role they play as Primes, and the geographical return requirements. Equipment suppliers remain the major contributors of equipment to these programmes. This increases the total amount of annual satellite equipment sales of the European Primes to 640 MEuro, or 45% of a total of 1440 MEuro for the 1995-97 period.

Opportunities for equipment suppliers are still present though. The ability of the two prime groups to manufacture an impressive number of different pieces of equipment does not necessarily indicate their effective frequent production of that equipment, and it is even less indicative of self-sufficiency. In fact, the evolving competitive environment creates a wide spectrum of possible scenarios and opportunities for equipment suppliers: new requirements of commercial programmes, unavailable from prime contractors for a given piece of equipment; or availlable at non-competitive prices following the «make-or-buy» policy; reliance of Primes on several parts of equipment which should be procured from specialised equipment suppliers; requirement of a second source, even for equipment perfectly mastered, etc. The extend of such opportunities will depend on the nature of equipment, mainly:

- **standard** pieces of equipment which can be sold to several prime contractors with no or minor adaptations, and
- **specific** pieces of equipment, closely related to the satellite's mission characteristics and/or those of the bus of a prime contractor.

Distribution of the European satellite equipment activity

Average annual values (1995-1997) provided by the industrial players (Euro in millions). Consolidated figures at the equipment level (only hardware manufacturing is considered, excluding AIT, software, etc.)



* Globalstar values (Euro in millions) estimated by Euroconsult

4. Structure and organisation of the satellite equipment sector in the US

4.1 Glorious past and good preparation for the future, with several key characteristics:

- **Enormous US institutional efforts**, both civil and military, during the last 40 years (combined annual US space budgets in 1998 representing an impressive total of 23.4 BEuro) have created a large number of specialised companies, and have constantly fuelled theier growth
- **Traditionally strong commercial approach** of US industrial players which has also led to a strong position in the world commercial markets early on.
- **Easier corporate financing and stronger entrepreneurship** have also been key factors in the recent evolution of the US satellite industry. Practically all important companies related to satellite manufacturing are traded in the stock market of high-technology values NASDAQ.
- **Well-stabilised industrial structure** made of Primes and of three levels of supply companies:
  - Major, traditional prime contractors, as well as newcomers, are fighting to take the largest share possible of the lucrative and risky new commercial markets. For some of them, this is in addition to their business with institutional programmes;
  - A wide spectrum of equipment suppliers, most of them world leaders in their speciality in commercial markets; they are responsible for the essential part of the supply to the US satellite industry, and of the exports to non-US Primes;
  - A larger number of lesser-known suppliers, involved exclusively in domestic institutional programmes; they are often industries located near various prime contractors or institutional centres (NASA, DoD);
  - A large number of high technology SMEs, acting as continuous sources of innovation for the rest of the industry; they solve technological challenges with specific institutional support, while equipment production continues to be the responsibility of equipment suppliers.

4.2 Increasing number of ambitious Primes, stabilising their vertical integration process

Hughes Space & Communications (HSC) has traditionally been the most vertically integrated of the three major US Primes. It is estimated that the company is responsible for over 75% of satellites' value for programmes in GEO, including integration and testing. However, a recent but important trend in the company is, on the contrary, to reduce its level of self-procurement, approaching the level of Lockheed-Martin, as a means of increasing its profit margins. HSC attaches a higher importance to its involvement as an operator for downstream added-value markets and as initiator or major participant in world-scale programmes (Spaceway, Expressway, V-Stream, ICO).

Lockheed-Martin (LM) is at a lower level of vertical integration (about 60%), including satellite integration and testing, in accordance with the level considered optimum for its satellite business. The company has the ability to manufacture practically all equipment on a satellite, but the «make-or-buy» policy is applied strictly to a large number of supplies, with a recent trend towards the reduction in the number of suppliers. Lockheed-Martin is also ambitious in downstream markets (operator LM Global Telecommunications-LMGT, joint venture LM/GE Americom) and the initiator of, or participant in, new world-scale programmes (Astrolink, Iridium), enjoying further integration thanks to the range of launch services it offers.

Space Systems/Loral (SS/L) has traditionally been the least integrated Prime, with less than 50% of the satellite's value, including integration and testing, and continues to function in this manner. It favours the award of as many satellite programmes as possible with lower self-procurement, avoids new internal development, and is ready to establish strategic partnerships at every level of procurement, including entire payloads, and a recent trend shows a return to space-specific suppliers, offering greater attention and follow-up on their clients. The company is also present as

an operator for downstream markets (Loral Skynet, Loral Orion, SatMex) and initiator of, or participant in, world-scale programmes (Globalstar, Skybridge, Cyberstar, Europestar, CD-Radio).

However, the three US Primes are no longer the only players for commercial satellites:

Motorola, a non-space telecommunications giant, already has experience as the Prime for its own Iridium system and would manufacture the payloads of Teledesic and Macrocell,

Boeing is ambitiously moving up in the added value chain: from platform manufacturing (Teledesic), to system integration (Ellipso, GPS-2F), and finally to systems ownership and operatorship, on top of launch services through Delta.

Orbital Sciences Corporation (OSC), better known for its small satellites and its small launchers, would propose full responsibility for the entire spectrum of satellites, up to 2000-kg GEO satellites.

Harris, a major industrial player in telecommunications payloads, has ambitiously moved to become prime contractor for the entire satellite.

4.3 Several strong suppliers are present in every satellite equipment domain.

A wide range of players following a long technological and industrial heritage

- About thirty US equipment manufacturers were examined during this study, representing the quasi-totality of companies figuring as the suppliers (especially in commercial contracts) of US or European prime contractors. They are considered the most active fraction of the US equipment supply industry, responsible for the greatest share of sales for this industry. Practically all satellite equipment suppliers are privately and publicly-traded companies. Most of them were established in the 50s and 60s, at the time of the emergence of ambitious US civil and military space programmes. However, practically all the most important players belong to industrial groups previously established in the defence and other sectors, from the 20s to the 50s (Kearfott, Allied Signal, Raytheon, Harris, Honeywell, Eagle Pitcher, Moog, Litton, Vacco, Teledyne).

Most suppliers enjoy a healthy business and are already present in constellation work, while a great number of them are world leaders in their fields, such as: Honeywell in mechanical wheels; Litton and Kearfott in gyros; Barnes and Ithaco in sun and Earth sensors; Eagle Pitcher in batteries; Tecstar in solar panels; Schaffer in mechanisms; Kayser-Marquardt in chemical propulsion; PSI, Keystone and Arde in tanks; Moog and Swales in thermal control; Harris in large antennae; Honeywell, EMS, Teledyne, Com Dev, and others in RF equipment; HP and Raytheon in SSPA's; Com Dev in switches, etc.

- Equipment suppliers belonging to large industrial groups (Harris, Honeywell, Litton, Allied Signal, Raytheon, Moog, Kodak, Hewlett-Packard, Texas Instruments, Teledyne, Vacco, Eagle Pitcher, Kearfott, etc.) generate annual corporate sales ranging anywhere from $200 million for Kearfott, to $8000 million for Honeywell. These industries are heavily present in the defence, aeronautics, launcher, and other high-technology sectors, creating a high level of synergy with satellite activity. Their large size leads to a satellite equipment business barely 2 to 15% of total, and most often less than 5%. Despite this relatively low share, the satellite equipment turnover can range from $10 million to up to $200-300 million, mostly from work on telecommunications payloads. On the average, the activity of these companies of about $100 million could be compared to the satellite business of the largest European suppliers, namely Bosch Telekom and Thomson Tubes Electroniques, which also work for telecommunications payloads.

- Smaller companies are specialised in one piece of equipment, or one equipment family, in which US Primes are relatively absent (AOCS, chemical propulsion, thermal control, mechanisms). Their total annual corporate turnover is of about $50 million and, on average, half of it comes from satellite equipment. Specialised suppliers in satellite equipment can be the world leaders, or among the world leaders, in their domain, having a relatively low

turnover ($10 million to $20 million). This is the case for example with ARC, Kaiser-Marquardt, and PSI in chemical propulsion equipment, Ithaco in AOCS equipment, Schaeffer in mechanisms, and Sage Labs in switches, filters, etc. More than 15 European suppliers have total satellite equipment sales ranging between $10 million and $50 million and they possess all the specificity and innovation to potentially play a similar role.

The equipment suppliers above, in addition to their strong presence in commercial markets, are also very present in US, and occasionally non-US (Europe, Japan, India, etc.), institutional programmes, which account for 20 to 80% of their total sales.

- In addition to these players, still more US equipment suppliers (estimated in 500 to 600 companies) work exclusively for the US institutional programmes. This is also the case in Europe, where a large number of European suppliers work exclusively on institutional programmes, as we have seen during this survey. The analysis of these US companies was outside the scope of this work, but their presence underlines the large number of US equipment suppliers that play different roles and occupy different niche markets.

- Innovative SMEs are supported and represent an engine of growth. The entire population of high-technology innovative SMEs can contribute with their advances to the manufacturing industry. This is possible via a support scheme, called the Small Business Innovation Research (SBIR). It is widely admitted that support from NASA and the DoD to hundreds of SMEs in space research every year completes the industry's organisation. These companies do not have product lines of commercial equipment but receive royalties from co-operating Primes and/or equipment suppliers for the technological advances they generate.

The structure of the US satellite equipment industry is largely stabilised. However, occasional concentration trends still exist, mainly due to the ambitions of some industrial players to attain synergy and critical mass. The examples in the last few years are the acquisition of Spar Space Systems by EMS Inc., of Astro Aerospace by TRW, of Able Technology by PSI, of Schaeffer Magnetics by Moog; of Keystone by Sundstrand Aerospace; of Hughes Defence Electronics, by Raytheon (includes stellar sensors). Primes are not motivated to acquire equipment suppliers. They are, rather, interested in the presence of smaller, independent, and thus more flexible and competitive entities, capable of selling to several clients.

4.4 Europeans are drawing lessons from a stabilised and robust US industrial organisation

It appears that the US satellite equipment industry enjoys a good balance between the roles of the three categories of players within the national and international competitive environment. Europeans seem to be heading towards a similar organisation:

- The recent emergence of world-class Primes, initiators of world-scale programmes, interested in downstream added value markets, and determined to strictly apply a «make-or-buy» policy;
- The presence of some strong equipment suppliers, creating a positive European export balance for satellite equipment;
- A large spectrum of abilities in a multitude of companies with low satellite equipment sales, most of them belonging to, and drawing synergy from, large space and non-space industrial groups. They are still almost fully dependent on European institutional markets, but able to become significant suppliers, and aware of the efforts necessary towards that end;
- A large number of smaller independent suppliers who could benefit from closer attention being paid to supporting SMEs, on top of numerous other non-space and unexplored European sources of innovation;
- Increasing awareness of institutional players regarding industry's competitiveness, as well as the role of innovation in a healthy space industry, and the support they should dedicate to that.

5. Conclusions and Recommendations

This international survey has provided both quantitative and qualitative information and the key conclusions of the study are presented below (§5.1 & 5.2). They show a stronger European satellite equipment industry, currently under re-organisation, which expects that ESA would fully play its roles as customer and source of support and as European institution. The general recommendations of the study that follow (§5.3) have as focal point the need for the emergence of a more efficient and mature industrial structure, through a common understanding of the respective roles of players, and a design of the institutional support accordingly.

5.1 The European satellite industry is becoming stronger

The recent years represented a turning point for the world satellite industry because of the conjunction of several factors :

- strong growth of commercial markets, driven by new applications in telecommunications, for both satellites in GEO and non-GEO orbits;
- slowdown of government markets, with the exception of some operational military programmes in the United States;
- technological advances and introduction of new key equipment, requiring expensive development;
- new manufacturing processes for serial production;
- increasing risk-sharing in world partnerships;
- intensive industrial concentration;
- competition increasingly global;
- rapid growth in productivity;
- etc.

For many years, the European satellite industry has been experiencing sub-optimal conditions compared to the US industry, its major competitor on the world market: huge difference in size of institutional programmes and R&D support, one-nation approach opposed to the multi-national European context, maturity of the US industry's structure and organisation, difference in size of commercial domestic markets and in market share on international commercial markets, intensity of new ventures, etc.

The conclusions of this study have shown that despite the US leadership, European companies faced the challenges and several positive factors are converging:

- Emergence of world-class European prime contractors, through mergers and rationalisation of their activities; the Alcatel and Astrium groups now have similar size of satellite activities as their US competitors.
- Demonstrated capability of equipment suppliers to become world or European leaders, or at least to have an important part of their sales coming from commercial markets. They have often benefited from well-adapted support (ESA and National Agencies), and have generated a positive trade balance for Europe. These companies are mostly involved in standard equipment for telecommunications payloads or platforms and target several prime contractors: Bosch Telekom (EPCs, switches), Thomson Tubes Electroniques (TWTs), Saab Ericsson (RF equipment, antennae parts), Fokker Space (solar generators), Teldix (mechanical wheels), ASE (Si solar cells), SAFT (batteries), Dowty (fuel tanks), ARC UK Ltd (satellite propulsion), Alcatel subsidiaries (ETCA, Alcatel Espacio, Alcatel Denmark, AME Space) in RF equipment or parts of equipment, GEC Marconi (gyros). However, only

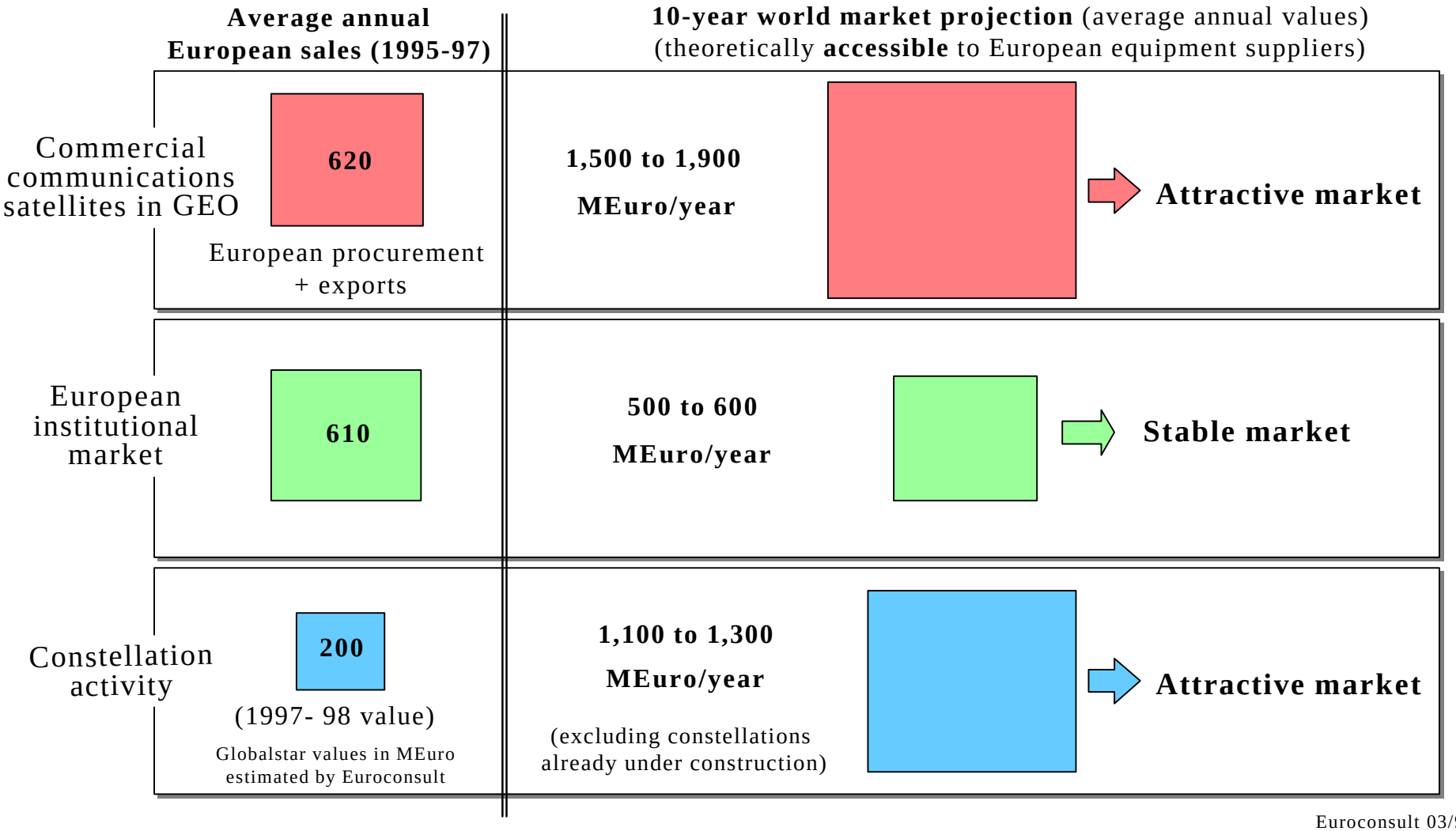
- six among these companies have annual sales in satellite equipment of more than 10 MEuros, a rather minimum limit for a supplier to play a significant role.
- Existence of several companies with small satellite equipment sales in niche markets (SSTL in the UK and OHB System in Germany being the most active companies, among others).
- Innovation capacity of European companies, including SMEs. Both European and US prime contractors underlined during this study the creativity of European suppliers and their capability to develop innovative products.
- Customer recognition of the high work quality of both European prime contractors and equipment suppliers. For instance, operators world-wide are well satisfied with European-built satellites, while European and American Primes have a good opinion about the work quality of European suppliers.
- Accessibility of most commercial markets in global competition. European suppliers sell to US prime contractors who are eager in including European sources in their procurement policy for competitive equipment with innovative features.
- Strong initiatives and/or participation in ventures for new applications involving European Primes (Globalstar, Skybridge, Teledesic, West, etc.).
- Growing awareness among suppliers, still present exclusively in European institutional programmes, of the need to target commercial programmes as well. This has been confirmed by increasing marketing efforts dedicated to these markets. Positive results were already obtained by several companies, while others, with more recent efforts, are expecting similar success.
- Technological heritage with strong synergy of equipment suppliers from high-technology sectors of large industrial groups. Parent companies are often either groups present mainly in non-space fields (defence, avionics, telecommunications, consumer products, etc.), or the two European satellite Prime groups themselves, having a direct or indirect capitalistic relation to one third of the companies surveyed. This heritage and synergy constitute a huge technological background for Europe and should be fully exploited by the European satellite equipment industry.
- New momentum among space agencies, both ESA and national agencies, towards a new approach, driven by the necessity to support the competitiveness of the European industry. The ESA initiative for the recent bilateral meetings with national agencies, delegations and industry, on the occasion of the presentation of the study‘s results, has shown a common understanding of the various issues.
- ESA’s commitment to play a key role in the necessary intra-European co-operation.
- Stronger European political will, confirming ambitions for new endeavours. The most notable examples are the Galileo-sat navigation system, receiving increasing support from European countries, and a better preparation for Earth observation markets.

All the factors for the European satellite equipment industry to be successful are present, at a time when commercial markets and opportunities were never higher in this industry’s history. Commercial world sales of satellite equipment (hardware) are estimated to be in the order of Euro 1.5 to 1.9 billion per year over the next ten years (satellites in GEO), plus an additional Euro 1.1 to 1.3 billion for the big-LEO constellations (excluding those already under construction). Despite the recent difficulties of the Iridium and ICO programmes, it is expected that big-LEO constellations will be an integral part of the global offer, even if the pace of their introduction becomes slower. The total of Euro 3.2 billion per year (and possibly more, depending on the future of complex and expensive multimedia satellites) represents 8 to 10 times the equipment value for the European-built GEO satellites in recent years.

However, the window of opportunity for the European industry may not remain open for long. As US competitors strengthen their technological advances and market shares, new competitors (Japan,

European satellite equipment industry sales and world-market prospects

Hardware value, excluding AIT, software, etc. - Euro in millions



South Korea, etc.) are emerging and gaining in importance. The European industry's move towards increased competitiveness should thus be accelerated. This is particularly challenging considering the multi-national diversity of Europe, as well as the traditional national objectives.

5.2 Europe should meet several challenges and ESA can play a major role

Future success for Europe signifies meeting three major challenges:

- the competitiveness of the European industry, focal point of this study, but also
- the accomplishment of non-commercial European and National space missions, and
- the long-term safeguard and improvement of European competencies.

Market forces alone will not be able to ensure all of these. To succeed at all levels, it will be necessary to exploit and amplify with maximum efficiency the slightest element of Europe's strengths, and to eliminate hurdles. This will not happen spontaneously, through simply reacting to events. Pan-European efforts have to be made at every level and these have already begun taking place, such as:

- This study, through the mapping of the European competencies and the quantification of the satellite equipment activities, was already the opportunity for European players in recent months to participate in bilateral and European meetings, sharing a common and objective vision and debating the various issues;
- An increasingly united Europe is emerging, and space applications are among the strongest unifying factors, both by nature and due to necessary competencies being spread out across the continent.

The European Space Agency is, in fact, the natural leader for the unifying role of channelling and fine-tuning all of Europe's strengths. The ESA enjoys unmatched advantages to accomplish this:

- credibility, backed by 25-year heritage, as the key European player in space;
- recognition by the industry itself, which is asking the ESA to play a stronger global role;
- legitimate status, following European governments' mandate to the ESA;
- own market of major strategic and economic importance;
- own significant state-of-the-art technological forces, closely interfacing with the industry;
- own state-of-the-art facilities, covering the most sophisticated needs;
- absence of any other European entity able to assume this role, even though the co-operation of all European and national institutional players is necessary.

Since the Ministerial Council of March 1997, new methods of working with industry have been initiated or further consolidated by the Agency:

- Increased interaction with industry in the definition of the key axes for industry's competitiveness (assessment of the sector, presentations and dialogue with industrial and institutional players);
- Announcements of Opportunity for Technology;
- Co-funding for pre-competitive activities;
- The SME initiative;
- The request for complete and binding offers for complete satellite developments;
- The emergence of the public-private partnership;
- The technology flight opportunities, providing industry with cheap access to space.

The European industry expects ESA to fully play its key roles

The above actions are recognised by industry as positive changes in the ESA strategy and approach. However, the intensification of efforts to meet all challenges will require ESA to create the maximum leverage possible through two major roles. This is effectively being asked by the European space

industry

- in the interviews conducted during this international survey, and
- in the national bilateral, as well as in European meetings initiated by ESA and carried out on the occasion of presenting this study's results to all European players:

- **As customer and source of support** for the satellite industry, ESA should maximise the effectiveness of its missions and R&D programmes. Despite increase of the commercial market's share, the institutional activity (both ESA and national agencies) still represents, for both suppliers and Primes, 42% of the European satellite equipment sales (58% for equipment suppliers alone), and 54% of the total R&D spending. The ESA missions and R&D programmes constitute the major part of this activity and should be used to create a very strong leverage for the improvement of the European competitiveness. Thus, according to the industry, ESA should:
  - Provide, as a strategic customer, a clear programmatic framework;
  - Increase the share of application-oriented programmes;
  - Tailor specifications of own missions as of inception by favouring development of equipment with commercial impact;
  - Simplify procedures at every level to increase overall efficiency;
  - Increase responsibility of Primes, when required;
  - Maximise use of existing standard equipment in own missions;
  - Facilitate industry's cheap access to space for equipment qualification;
  - Maximise the benefit for the industry of the ESA specialised personnel and assets.
- **As European institution**, ESA should play, according to the industry, its natural role to initiate and intensify co-operation and act as a catalyst in the European satellite sector:
  - Guarantee a consistency between European and national space efforts;
  - Act as a facilitator between Primes and equipment suppliers by providing reliable and objective information;
  - Favour the interaction between Primes and equipment suppliers;
  - Create a European consensus as to where the best chances of success are to be found;
  - Foster the possible synergy between space and non-space industrial and innovation forces;
  - Monitor the European and world satellite business environment and its drivers.

Such a vast array of possible actions expected from ESA underline the common understanding that the future of the European satellite equipment industry is a pan-European issue and not a sum of national ones; thus, it must be addressed at the European level. A common goal which would unify all players, both industry (prime contractors and suppliers) and institutions (ESA and national space agencies) is the optimisation of this industry's structure.

5.3 ESA should favour an efficient industrial structure as major European space policy maker

As the key recommendation of this study, the central target of the ESA actions through its multiple roles should be the consolidation of a solid and harmonised industrial structure in the European satellite equipment sector, namely:

- **strong prime contractors,** as a main driver of the European industry;
- **a greater number of strong equipment suppliers**, proposing standard products to several prime contractors world-wide;
- **companies specialised in the specific requirements of institutional missions;**
- **a larger family of small, flexible and innovative entities** with excellence in space and non-space fields, guaranteeing a continuous flow of innovation within Europe.

Today's structure of the European industry is the 25-year heritage of a multitude of nations working towards the emergence of a European industry and the undertaking of world-scale missions. The recent meetings between ESA and the rest of the European players (national agencies and/or delegations, prime contractors, equipment suppliers) have confirmed the study's conclusions and analysis, and have enriched the debate as to the relative role of players, and to the consequences of the geographic-return policy :

- **Prime contractors** have practised in recent years a 50% self-procurement of the equipment value for their commercial satellites in GEO, a figure that rises to about two-thirds, once including procurement from subsidiaries or companies related to prime groups. Primes have already act to improve competitiveness by merging and rationalising their capabilities. They define what equipment is strategic to their business, and they are determined to apply a necessary «make-or-buy» process, driven by the low margins of global competition.

- **Equipment suppliers** are concerned by shrinking institutional budgets, since most of them are very dependent on these markets. A great number of these companies are aware of the commercial attitude they should adopt, when they have not yet adopted it, while others wish to strengthen their role as specialists in state-of-the-art institutional missions. Relatively few European equipment suppliers contribute to the commercial and/or export sales and they should be further strengthened. Finally, 32 of the companies surveyed (50% of total) have sales of satellite equipment for less than 5 MEuro and an average annual turnover of 2.5 MEuro. They occupy niche markets with potential for both commercial and institutional missions, and several of them are SMEs.

- **National space agencies**, especially the largest ones, play an important role in completing the ESA R&D support of their national companies. Indeed, the dominant position of prime contractors in the ESA programmes, as well as geographic return constraints, do not leave enough room for ESA R&D support to Primes or to suppliers in the same "large" countries. The criteria for the national R&D support are those of national interest and often lead to sub-optimal use of the limited European funds (e.g. non-standard equipment developed by Primes strictly for their own use, R&D conducted by suppliers for products without commercial perspectives or very similar to ESA-supported R&D work, etc.).

- **The European geographical return policy**, which has been instrumental in the creation of the European space industry, is now recognised by all as the major reason of the excessive fragmentation of European competencies observed in several equipment families, resulting to small-sized players, unable to play a significant role in commercial markets. The geographical return could allow the European competitive and innovative forces to grow, under the assumption of there being one or two competitive equipment suppliers for each type of equipment or parts of equipment in Europe, and that these suppliers are distributed among the various countries according to the heritage and specialisation found in each one of them,. Companies, specialised in prototyping state-of-the-art institutional work, would also have the room to develop, despite their deliberate absence from commercial markets, and would complement a country's contribution. A clear choice by each country, combined with corporate strategic decisions, will be needed for a more integrated and competitive national industry.

A more efficient and mature European industrial structure, at the image of the situation in the US, could be achieved through an adapted distribution of the institutional work. The ESA policy on procurement and R&D support should be adapted and applied in its daily practice according to two key elements:

- a common understanding in Europe of each player's roles and

- a clear demonstration of fairness at each step of the process.

Design institutional support according to the relative roles of industrial players

This should apply to each type of equipment, according to the nature of the equipment, the major roles of the companies active in this equipment, and their determination to provide a specific added value. This policy, applied in co-ordination with national space agencies, will help emerge a more concentrated and efficient European bid.

- **The nature of a satellite equipment** to be developed is a key element for a common understanding of each player's roles (standard equipment, able to be sold with no or minor modifications to any prime contractor world-wide; equipment specific to a given platform; or equipment specific to the mission).

  A first judgement of whether an equipment is rather standard or specific for satellites in GEO was made during this study by the European Primes, and it is presented in the following figure, correlated to the overall self-procurement level of Primes during the last few years. It illustrates an unbalanced situation, due to the very high level of Primes' self-procurement for several families of standard equipment, expected to be the domain of specialised suppliers. This presentation can help European players to share a common image of the present status, and to agree on a more adapted distribution of institutional R&D support, depending on the nature of equipment and the role of companies:

- **Genuine equipment suppliers** should be supported for the development of standard equipment sold to several Primes, or of some mission-specific equipment, sold regularly in tight co-operation with Primes. These suppliers should propose high value-added products, recognised as such by Primes, and have long-term commitment to technology and to commercial markets. Even for the most strategic types of equipment, equipment suppliers could always propose their co-operation for part of the work under strategic agreements.

  If a supplier has a potential market lower than that of a single prime contractor who manufactures the same equipment, his added value may rather be related to sub-contracting work to Primes' design, due to the supplier's smaller size and lower costs, than to an own product line. This is also the case when a supplier manufactures parts dedicated to the equipment of a specific platform.

  Suppliers with the strategy to remain in institutional programmes should concentrate on specific, non-standard equipment (equipment with particular specifications, scientific instruments, etc.), thus complementing the specific challenges of such missions with their specialisation.

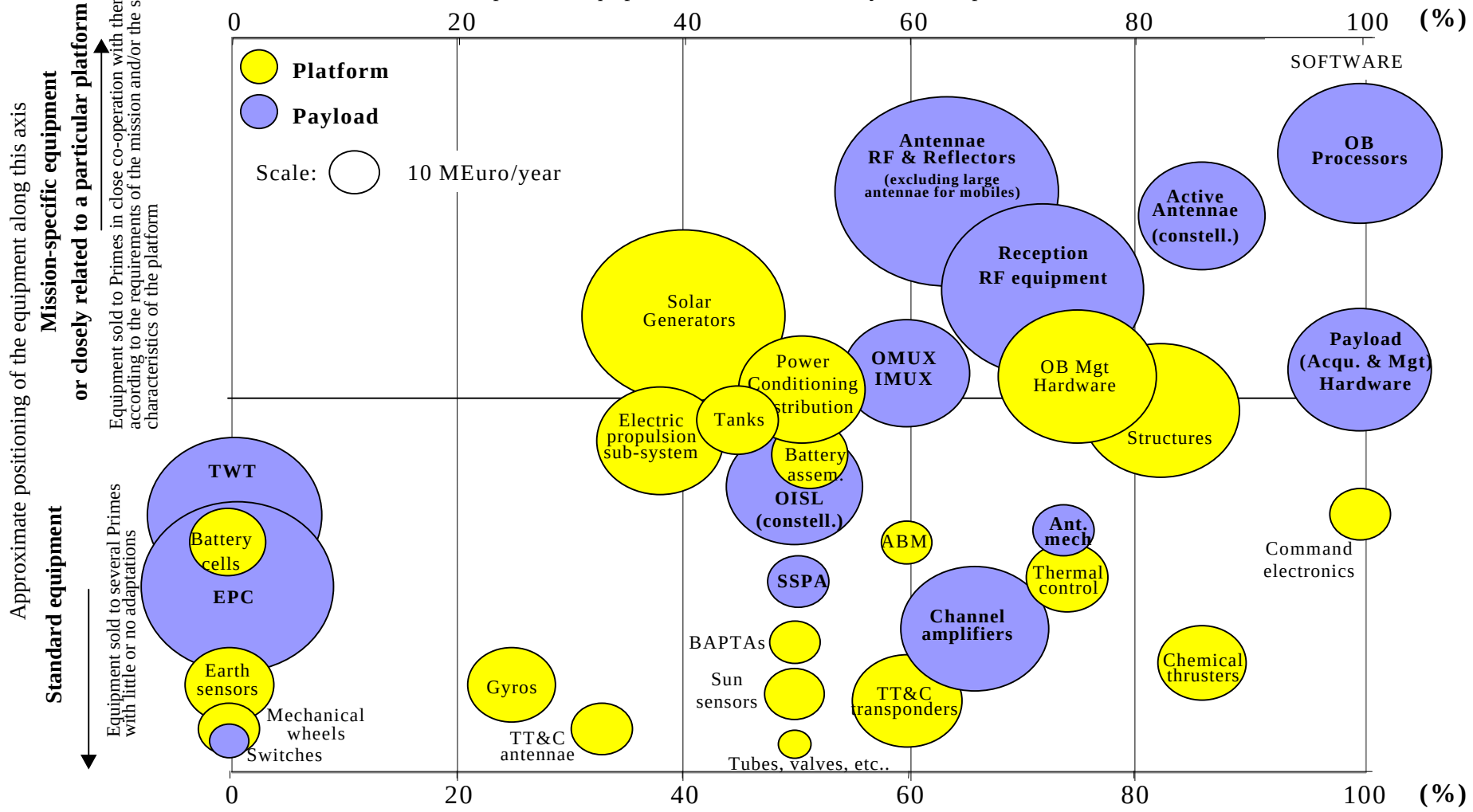
  Subsidiaries of Primes who are genuine equipment suppliers should also be considered at the same level as independent suppliers, if their equipment fits the needs of non-parent companies too, and if the subsidiary is committed to targeting the global market, assuming the Prime consent. Subsidiaries are considered integral parts of parent companies in the "make-or-buy" policy, but competitor Primes' markets are also open to them for the procurement of standard, competitive products.

- **Prime contractors** themselves are the ones best suited, alone or in close co-operation with specialised equipment suppliers, for mission-related equipment, adapted to their platform and its missions. These pieces of equipment are thus closer related to their key role as satellite inceptors and integrators, guaranteeing the performance of the entire satellite mission. The most strategic of these pieces of equipment constitute the differentiating factors of a Prime's bid, face to competitors' satellites.

  Primes may also be the unique European provider of standard equipment, due to strong internal synergy and long tradition. However, a supplier with an innovative and potentially competitive product may appear, determined to target the rest of the European, and especially the world market, creating a potentially higher leverage for the European economy. During the consolidation phase of Prime groups, which may last at least 2 to 3 years, special attention is needed to accurately assess the effectiveness of such support to non-stabilised internal teams,

Relative Economic Importance of Satellite Equipment and Level of Primes' Self-procurement - Parent Companies

Market of satellites in GEO, unless otherwise noted.
Surfaces illustrate the approximate size of the average **annual world** commercial market 1998-2007.
Introduction or withdrawal of a piece of equipment over the next ten years and price evolution are taken into account.



Recent past and likely short-term self-procurement of the two European Prime groups

Percentage of the equipment value. Only parent companies: Alcatel & Astrium (MMS, DASA, Alenia) taken together, excluding subsidiaries.
Consolidation of average estimates provided by European Prime, including sales between Prime groups. Euroconsult 06/99

due to a temporarily low visibility in the internal process of the group, and possible withdrawal from this activity.

Single or multiple European sources for a piece of equipment and the risk of dependence on non-European sources, are debates fuelled by the presence and ambitions of a large number of equipment suppliers for a wide range of products, a situation considered as a by-product of the pan-European accomplishments in the space field during past decades.

- At the **equipment level**, the industry considers that Europe does not suffer from a high risk of dependence. The risk assessment varies from specialist to specialist, as well as from prime contractors to equipment suppliers, depending on each one's judgement of the current health and long-term prospects for European sources. Dependence for an equipment could be technological (due to more advanced know-how outside Europe), but also economic, due to much more competitive prices elsewhere. Multiple European sources for an equipment may not be a guarantee of European independence, if the suppliers are weak with bleak perspectives. On the contrary, a large successful company with bright perspectives and long tradition in satellite equipment business could be the sole but adequate source for Europe.

  The recent export restriction policy of the US, which could be become even stricter in the future, is another major issue for Europeans to consider. It upsets the procurement policy of European Primes for some equipment and illustrates the further efforts needed for a long-term independence of Europe.

- At the **component level**, Europe suffers from a considerable strategic dependence on external sources for all elements necessary to the manufacturing of several key equipment families. These components are namely: micro-electronics for onboard computers, processors and mass memories, high-power components for SSPAs, GaAs for solar-generator cells, and new materials for structural parts. Even though the issue of dependence on satellite components is well-known and was outside the scope of this survey, it conditions long-term performance and dependence at the equipment level, and represents a major concern for European players. It thus should be addressed and solved at a pan-European level.

The risk for Europe at the satellite equipment level is thus not strategic, but economic and industrial. Due to the size of the European market, a sole source, independent to Primes, for key equipment would be sufficient, depending on the type of equipment. However, this unique source should be large enough to cope with product standardisation, comparable to that of non-European competitors. Half of the European suppliers surveyed have an average annual satellite equipment turnover of about Euro 2.5 million. This would only make them useful as sources of innovation for a specific technology, or with an excellence in a niche market for few clients. Signs of concentration have already appeared and they could gain momentum in the near future.

A sole European source would introduce some significant problems, though, such as:

- opposition with the «double-source» principle of institutional procurement, which assumes competition and selection. The creation of monopolies may introduce legal problems and will require price control, according to objective commercial price references;
- potential European dependence in case of the unique supplier's withdrawal. This could be solved by offering a longer visibility to the industry, through long-term agreements for procurement and R&D support;
- guarantee of fair treatment to all Member States, which would depend on the presence of market leaders in each one of them.

A fairness must be the guide, according to the roles and capabilities of the companies

A major concern of the industry is the fair treatment they expect during the entire process in the distribution of the ESA support (participation in missions and R&D work). This concern was underlined especially by the satellite equipment suppliers, during their national bilateral meetings with ESA, on the occasion of presenting and debating the results of this study. The major recommendations of the study in this respect will enable to foster fairness, and to enhance the efficiency and credibility of the ESA actions towards a stronger structure of the European industry:

- **Introduce procurement criteria of economic and industrial nature**, in order to guarantee the effectiveness of support for the competitiveness of the European industry as a whole. A company that could be a European leader should posses the industrial and commercial capacity to address world markets, and have a consistent development plan. A strong internal synergy, in terms of generic technological development carried out in adjacent parts of the company, or availability of the means of production, guarantees an even better effectiveness of European expenditures. A procurement policy based only on the technical quality and experience of companies will not lead to the required results.
- **Guarantee a solid commitment of suppliers** to move on with a commercial approach for their equipment, by requiring partially self-funded development. This is already ESA practice, and is reportedly giving very encouraging results. A more systematic approach to all the ESA programmes should now be implemented.
- **Establish agreements of co-operation with unique equipment leaders** of a domain, if this is justified by the competitiveness of the European bid in the international market. Such agreements could take the form, for example, of R&D or batch orders. The ESA will thus help European leaders maintain and strengthen their competitive position in the face of, often, bigger or new non-European suppliers, and to prepare themselves for new generation products.
- **Favour early involvement of key suppliers in missions** to help harmonise their work with Primes. This will allow for the optimisation of equipment, as well as the entire mission. This practice will contribute in establishing or maintaining longer-lasting relations between Primes and suppliers in subsequent commercial programmes.
- **Be ready to invite any innovative solutions coming from new space and non-space entities**. They should not be considered by established players as competitors, since these entities are generally small, have origins in the research area, and have no intention or capability of creating production lines for equipment manufacturing. They are, rather, additional sources of innovation, key elements for European competitiveness and the accomplishment of quality missions, as well as the improvement of European competencies. The US initiative SBIR has become, in a short time, the recognised engine of growth for the entire equipment industry. The recent SME initiative of the ESA is already a reality, and industry shows satisfaction, encouraging an increase in its scope.

It is widely recognised that today's opportunity for Europe will not appear again soon. The stakes are high; and the European satellite equipment industry should not shrink, while the world satellite market expands. The results of this study are already being used by ESA to build a common image, and future European missions, such as Galileo-sat, must be the fields of application for the shared ways of action. Every satellite equipment family constitutes a specific case though, and the paragraphs that follow summarise the context of each equipment family, and the outlook of its perspectives.