International overview of space governance and policies for the Canadian Aerospace Review

Final report

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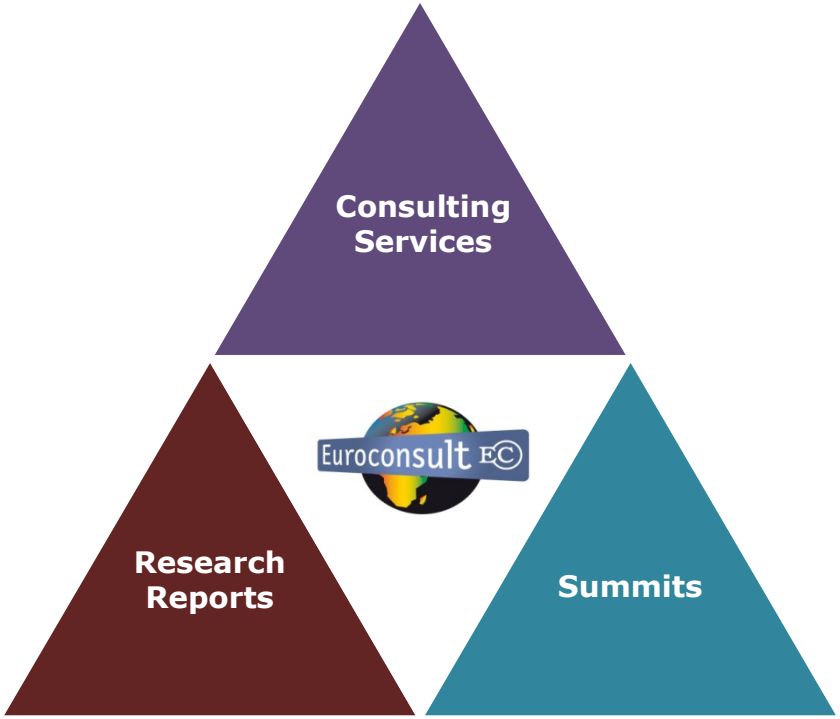
Who we are and what we do

- Established in 1983, independently owned and operated
- A reference for analysis & consulting in satellite applications and industries worldwide
- Offices in Paris, Montreal and Washington DC
- 500 customers in 50 countries
- Our mission is to support decision making for private and government organizations in the satellite business
- Expertise includes independent assessments of business plans, government policies, market estimates, financial valuations, risk assessment, due diligence, strategic support
- Has developed over the last 15 years a series of recurring multi-client market surveys that tackle the major economic, financial, policy and industrial issues



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Background and scope

Scope	•In May 2012, Euroconsult North America was mandated by the Aerospace Review Secretariat to undertake an Assessment of Space practices as part of the Aerospace Review taking place concurrently. •The study aims to provide an international review of space governance and policies. •The objective of the work is to provide a survey of governance models, strategies & policy orientations with regards to the space programs & industry across a selected number of countries of relevance to Canada.
Sources and methodology	•Eight countries, plus Canada, were selected for analysis with the Aerospace Review Secretariat based on their relevance to Canada and information available: Brazil, France, Germany, Japan, Norway, South Korea, the UK and Italy. •The selection was based on 3 criteria related to national space activities: government budgets, applications covered and the existence of a space agency, with selected countries having at least 2 in common with Canada. It was agreed that this selection constitutes a suitable sample to provide the necessary information to derive the analysis of Canada's positioning. •A standard profile assessment was done for each country, under a systematic and similar way. Domains of particular interest assessed were proposed by the team and refined with the Aerospace Review Secretariat to be: 1. **Space program governance** : an identification of all government organisations involved in the national space programme and the organisation of the decision making process (institutional frameworks, ministries and agencies involved, responsibilities, decision making responsibilities). 2. **National space strategy & policies**: past, present and future objectives in space, rationale for evolutions, priorities between key applications, instruments used to formalised the national space policies, including both civil (domestic & international) and defense contexts. 3. **Budget trends**: historical trends, detailed distribution of current funding, anticipated trends for the next years; civil versus defense distribution of investment, as well as national/ESA distinctions where relevant and detailed breakdown by application. 4. **Industry policy**: existence of a policy to support the development of the national space industry, how it is formalized and articulated, structure of the national industry through key statistics (revenues, companies, staff…) and key national champions. •This information enabled a benchmark analysis of the selected countries, highlighting the positioning of Canada.
Limitations	•Publically sourced data was used –the accuracy of all information can therefore not be guaranteed.
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Section 1:
Benchmark

Governance

Benchmark of the national space governance

•All countries surveyed have a space agency. Two of them restructured their space administrative framework in the 2000's: Japan merged a number of research institutes to move from basic research to utilization while the UK streamlined from a voluntary partnership of 10 departments, agencies & research councils to remedy a lack of focus.

•The supervision of the space program is devoted to Education/Research or Trade/Industry Ministries depending on the focus of their space program. However, a growing number of governments have shifted the supervision of their space program to Trade/Industry as part of an overall strategy to prioritize space applications over space science and research. In some cases, decision-making on space matters directly involves the highest Executive level (France, Germany, Japan, S. Korea).

•Defense has become increasingly integrated in national space program with co-funding (to space agency or program basis) and aligned decision making.

•In addition, the majority of benchmarked countries have permanent or *ad hoc* intra-governmental committees overseeing the governance of the national space programs to ensure that the national space policy reflects the needs of several users and development areas.

Canada's position within the benchmark

•The governance of the Canadian space program is in line to the benchmark countries (space agency, Ministry of industry supervision, greater involvement of Defense etc,). However, the political dimension of the decision-making process can be considered more limited with direct development of the national space policy from the space agency, rather than at government level (similar to Norway). The absence of permanent committee for space and the lack of direct relationship to the Government top Executives is also a difference compared to countries having set space as a key government priority.

Benchmarked countries' space governance: key data

	Brazil	Canada	France	Germany	Italy	Japan	Norway	S. Korea	UK
Agency creation	AEB (1994)	CSA (1989)	CNES (1961)	DLR (1969)	ASI (1988)	JAXA (2003)	NSC (1987)	KARI (1989)	UKSA (2010)
Ministry reporting to	Science & Technology	Industry	Higher Education & Research /Defense	Economics & Technology	Education, universities & Research	Education, Culture, Sports, S&T	Trade & Industry	Education, Science & Technology	Dpt. for BIS
Defense involvement	Low but increasing	Increasingly involved	Fully involved	Increasingly involved	Fully Involved	Low but increasing	Low but increasing	Low	Involved
Intra-government committees	No	Ad hoc	Steering Committee	Inter-ministerial Commission	Inter-ministerial group	Strategic Hq's for Space Policy	No	National Space Committee	Space Innovation & Growth Team

Space Strategy & Policy

Benchmark of national space strategy & policy

•All countries benchmarked have dedicated space plans/strategies, usually issued every 5-10 yrs; interim consultations can occur during transitions (e.g. BNSC/UKSA). Issued mostly by civilian government authorities, space plans are either devised by space agencies, ministries or a combination of the 2. Defense organizations rarely provide contributions to these; they rather input space –related topics into their own defense plans.

•These mostly civil-driven strategies are centered around building, expanding or maintaining a strong domestic space industry, focusing on leveraging niche capabilities where applicable or assuring leadership depending on the competitive level of the national industry. While some countries are ramping up their overall defense efforts, space strategies are being examined within a dual-use concept to support national security objectives, particularly as stringent budget situations persist.

•Only a few countries can invest in the full spectrum of space activities as developing or maintaining leadership in all domains of the space value chains and applications is extremely costly. Some countries have even revisited their plans and decided to refocus their effort for better efficiency (Japan). The majority of government focus on generating economic return to their industry therefore giving priority to satellite-application driven programs rather than scientific and infrastructure programs.

Canada's position within the benchmark

•The CSA has been directly in charged of the revision of the national space plan, but contrary to most countries the process was not connected at Federal government level, therefore it lacks political impulse.

•The absence of a long term strategic vision makes the orientations of the Canadian space program less clear than benchmarked countries. Greater consideration for security and sovereignty drive current flagship projects with increasing consideration for dual-use programs. Canada appears less focused on satellite application R&D, than other countries who increasingly put industry competitiveness as a no1 priority, focusing rather on operational procurement.

Benchmarked countries' space strategy & policy : key data

	Brazil	Canada	France	Germany	Italy	Japan	Norway	S. Korea	UK
Space Plan	PNAE(2005, under revision)	Space strategy (2005)	Space Strategy (2012)	Space strategy (2010)	Strategy Vision (2010-2020)	Basic Space Plan (2009)	Long-Term Plan (date unknown)	Ntl' space Plans (2007, under revsion)	Ntl' Space Strategy (2008)
Issuing authority	AEB	Ministry of Industry	Ministry of Education & Research	Min. of Economics & Technology	ASI	Strategic HQ for Space Policy	NSC	Min. of Edu., Science & Technology	Dpt Business Innovation & Skills
Guiding priorities	End to end autonomy	Sovereignty and security	Industrial Leadership	Industrial Leadership	Industry leader & ntl' security	Security and industry development	Security and economic return	Autonomy in critical capability	Economic return and ST
Leading applications	EO, launchers, Satcom	EO, robotics, satcom	Launchers, EO, satcom	EO, Satcom robotic,	EO, launchers, science	Navigation, science & exploration	Satcom (AIS)	EO, launchers	Space science

Benchmark
Space Expenditures

Benchmark of space expenditures

•Three countries spend over a billion dollar in their space program, illustrating their historical leadership in the global space sector: Japan, France and Germany. The UK and Canada invest more than $500 million/year across civil & military programs, both having the recent past years re-increased their financial effort in their space program. Three countries spend around $100-200 million/yr, including 2 new regional leaders (Brazil and S. Korea) and 1 mid-size European country (Norway). Unsurprisingly, this ranking is also valid for the financial effort invested by a country's GDP : leading countries still invest more of their national resources to their space program than others.

•Over the past 5 years, all benchmark countries increased their allocation to their space program in a strategy to support a technology intensive industry in a period of economic crisis or to continue to support their capability building (e.g., Brazil, S. Korea transitioning from 1st to 2nd launcher version).

•Facing tough public finance constraints, countries will react differently in the coming years, distinguished by: those maintaining their financial support to protect their industry, emerging leaders maintaining their growth spending to catch up with historical leaders capabilities and those choosing to reduce their space spending as a contribution to further government spending reduction and prioritizing their investment.

•Canada's position within the benchmark

•In terms of budget (civil and defense), Canada ranks 5th out of the 8 benchmarked countries. It also experienced a representative growth throughout the past decade.

•In terms of financial effort as of GDP, Canada ranks 4th, with a ratio of 0,03% which is in the average of the benchmark sample.

• Recent budget growth was largely influenced by the past 3-yrs defense spending and the stimulus package, placing it 2nd place in terms of growth trends. However, Canada is expected to witness the biggest budget cut compared to a flat average amongst benchmarked countries.

Benchmarked countries' space expenditures: key data

	Brazil	Canada	France	Germany	Italy	Japan	Norway	S. Korea	UK
2011 spending C$ millions	222	593	3078	1955	1131	3546	117	208	715
Space budget /GDP (%)	0.01	0.03	0.11	0.06	0.05	0.06	0.024	0.02	0.03
2006-2011 CAGR (local currency)	+8%	+13%	+1%	+6%	+6%	+2%	+16%	-6%	+2%
Civil space % & 5yr CAGR* (past → future)	99% +8% → +9%	73% +6% → -4%	84% +2%→ +2%	90% +5% → 2%	86% +4% → -1%	69% +1% → 3%	88% +13% → 3%	100% -6%→+3%	70% +3%→ 2%
Defense space % & 5yr CAGR *(past → future)	1% -7% → +5%	27% +39% → -5%	16% -5% → +6%	10% +43%→ 7%	14% +23%→ -10%	31% +6%→+3%	12% 0% → +42%	n.a	30% 0%→ 1%

CAGR* : Compound Annual Growth Rate

Benchmark
Space Industry

Benchmark of space industry

•Turnovers and jobs displayed in the table below are not directly comparable, as some national statistics include satellite communication revenues in the downstream sector (e.g. UK, Canada) while others exclude these services from their space industry data (e.g. France, Japan).

•Most space industry develops through the direct support of its national space program; the key difference between countries is on the ability of their national industry to compete on the international market and derive a sustainable business. National industries that have been successful have all benefited from a sizeable domestic market on which they have been able to develop and demonstrate cost competitive and reliable capabilities, before competing on the international market.

•Other tools are used beyond direct funding to support industry competitiveness. In particular, export credit agencies are now playing a key role to help national companies winning international contracts.

Canada's position within the benchmark

•Canadian industry figures take into account the downstream sector (such as satellite TV) therefore overestimating the real size of its space industry *per se*.

•The industry has developed pioneering technologies, positioning Canada as a leader in niche areas through government funded programs but with recurring difficulties to translate into leadership across the commercial market.

•The absence of a sizeable domestic market and of a strong industry policy / strategy contribute to an increased gap between Canadian players and their competitors.

Benchmarked countries' space industry: key data

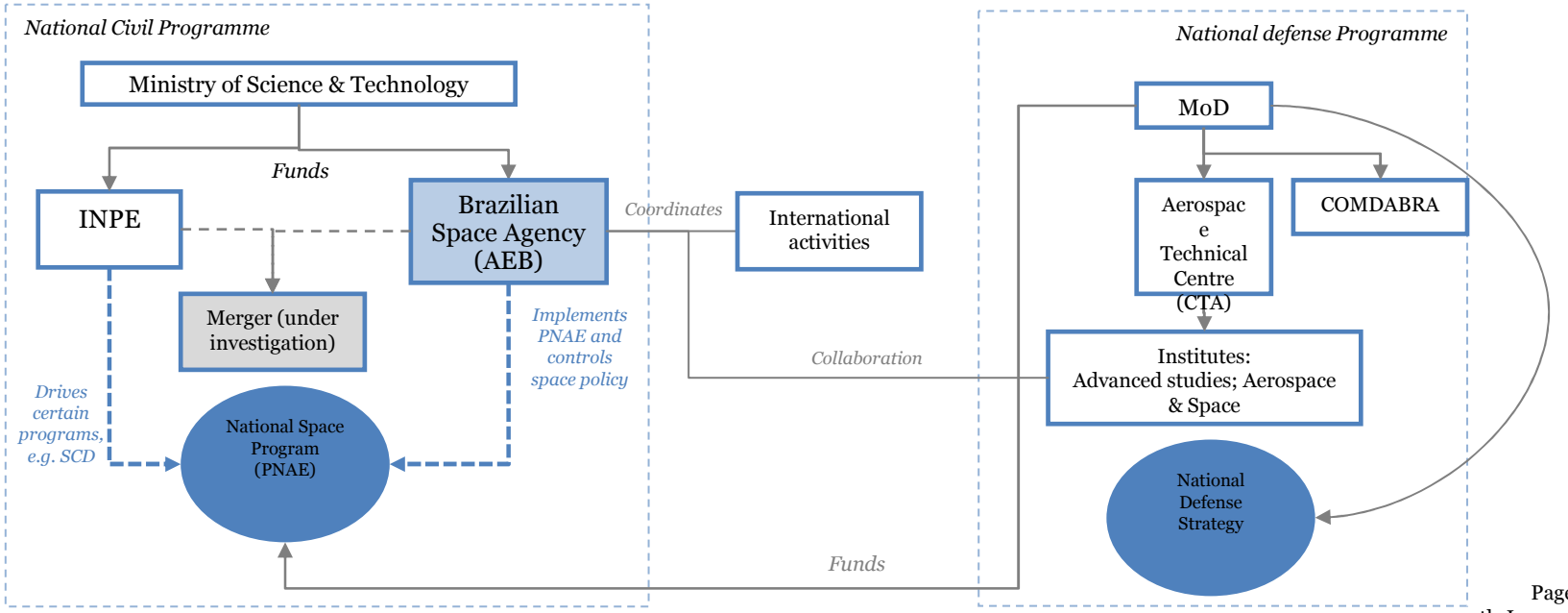
	Brazil	Canada	France	Germany	Italy	Japan	Norway	S. Korea	UK
Turnover C$ millions	66	3443	6300	2760	1368	2757	1000	181	13600
Jobs	3400	7500	13,000	7500	3000	6,250	302	1381	24900
Industry support scheme	Generic	Generic	Swarming policy	High tech strategy	3-yr cooperation agreement	Basic Space Law/Plan	Nat'l Support Scheme	Generic	Dedicated (S-IGS)
National champions	OMNISYS, AVRIBRAS, Orbisat	MDA, Telesat	EADS Astrium, TAS, Eutelsat	OHB, MT Aerospace, Serco	TAS, Avio, Telespazio	MELCO, MHI, NEC	Kongsberg	KAI, Satrec Initiative	SSTL, Cobham, Avanti, Inmarsat
Key challenges	Lack of skilled labor force	Size of internal market, intl compet'ness	Tough commercial market	Reduce reliance on government	Reduce reliance on institutional programs	Size of internal market, intl compet'ness	Niche expertise and a few players	Technological and industry maturity	Long term R&D support

Section 2:
Country Profiles

Governance of the national space program

Outlook of key government stakeholders and decision making

- Until its transfer to the Ministry of Science & Technology (S&T) in 1994, the Brazilian space program was under the control of the Brazilian military. The **Brazilian Space Agency (AEB) was then created** to implement the Brazilian **civil space program** and coordinate national & international activities.
- In parallel, the **National Institute for Space Research (INPE)**, formed in 1971 and also reporting to the Ministry of S&T, aims to foster **scientific research** and **technological applications** across the fields of Space and Atmospheric Sciences, Earth Observation, Meteorology, Space Engineering, and Technology. It is responsible for the design and contracting out of national missions to industry.
- In a bid to **consolidate and grow** across wider space areas, the Ministry is reviewing a proposal **merger** between AEB & INPE that would result in the creation of a larger space agency. Managed by a single entity, it would also increase the involvement of the private sector.
- Military space activities are essentially ran out of the **Aerospace Technical Centre (CTA)**, reporting to the Ministry of Defense's Air Force Commandant. CTA is responsible for technical & scientific activities pertaining to the national military research center for aviation and space, particularly concentrating on launchers.
    - CTA is supported by several **institutes**, whose roles revolve around **developing space technology & exploration capabilities** through education, including: Aeronautics & Space Institute (IAE), the Technological Institute of Aeronautics (ITA) and the Advanced Studies Institute (IEAv) – also known as the General Command for Aerospace Technology.
    - The Brazilian Aerospace Defense Command (COMDABRA) is responsible for integrating the country's aerospace monitoring capabilities.



Space policy and strategy outline

National Space Strategy

- Brazil's space program is guided by the **National Space Program (PNAE)**, adopted in 2005, which established priorities for the 2005–2014 period. It focuses on 3 initiatives of national importance: the development of the flagship CBERS Earth observation program, building national launcher capabilities and the development of a domestic dual-use satcom system (SGB).
- Since mid-2010, AEB has been working on the definition of a new ambitious PNAE covering the 2012-2015 period. In a bid to revamp the nations' space policy and activities, new additional priorities will be to establish:
    - A **national defense strategy** and a national system for **disaster warning and prevention**, as well as improving environmental monitoring, ensuring food & water security.
    - A **variety of topics** ranging from raising space educational awareness to space weather monitoring.

Brazil domestic program

The main priorities over the past decade and as of today are predominantly launcher and EO related, ensuring autonomous capacity from domestic systems:

- **EO** is AEB's most important area, driven by the 20-year+ flagship **CBERS** bilateral program with China and the future domestic system, **Amazonia**. These will continue to serve Brazil's needs particularly in terms of natural resource monitoring, while ensuring shared data use with selected countries. By 2018, a dedicated meteorology mission, SGB-2, is also set to be deployed, focusing on the country's vast territory.
- The development of autonomous **launcher capabilities** by 2020 has been a longstanding effort and is currently being addressed under a "**critical technologies**" program. Its mandate is twofold:
    1. To ensure domestic satellites can be deployed at no further cost to Brazil from its own soil and from its own operations.
    2. To position itself as a world-class strategic launch service provider for geostationary satellites, based the prime location of its launch pad (2°S of the Equator). This would enable Brazil to become a potentially commercially competitive player amongst the launch service providers of the world.
- **Satcom** has also more recently **become more important**, driven by the need to expand broadband infrastructure across the country, particularly in schools and remote areas. Demand for extra capacity has been boosted by the upcoming 2014 World Cup and 2016 Olympic Games, driving demand for a dual-use SGB geostationary system, the first satellite of which (SGB-1) is expected to be operational by 2014.
- Science and technology programs are undertaken to support domestic capacity building and to serve domestic missions/applications, through collaboration.

International collaboration programs have largely been bilateral, as there is no main regional cooperation body:

- One of the earliest partnerships begun in 1988 with China to develop Brazil's space technology capabilities through the **CBERS** project . Cooperation has twice been renewed, lastly in 2004, and it expands to wider countries through a free data sharing policy. This has in fact led INPE to join the International Charter on Disaster Management and involvement in CEOS. Other **EO cooperation** programs have since emerged with Germany , NASA/JAXA and Argentina for developing application-specific missions directly relevant to Brazil's geography (e.g. MAPSAR for cloud-penetrating tropical forest monitoring).
- Linked to this, **technology** activities have relied on cooperation: e.g. CNES co-development of the **Multi-Mission Platform** on which Amazonia is based.
- Since 2005-6, 2 key **launcher developments** have heavily relied on foreign cooperation, mainly from **Russia** (Southern Cross (SCW) project) and **Ukraine** (Alcantara Launch Center), based on Soviet-era rockets. With testing due in 2013-14, operations are set to begin around 2020 for both entities.

Defense programs

- There is officially **no MoD Space strategy**; defense space activities are, for now, largely influenced by the **2008 National Defense Strategy**, focused on providing competitive solutions to the Armed Forces. The Strategy mentions the role that space resources can play within the wider defense strategy:
    1. To produce satellite-launching vehicles, focusing upon inertial systems and liquid propulsion
    2. To develop technologies for high resolution monitoring, from air and ground, and ensure communication between systems
    3. The national defense industry will be instructed to give the highest priority to the development of the necessary technologies, including those that promote independence from the GPS system, or from any other alien positioning system.
    4. The development of high and low orbit satellites.

  The Brazilian Aerospace Defense System (SISDABRA), reporting to the Brazilian Aerospace Defense Command (COMDABRA), plans to include launch vehicles and satellites as a integral part of the system.
- Asides from these technology-based requirements which are largely taken care of by military research institutes undertaking space S&T activities, national space related defense activities are inherently thought to be devised within a **civil protection strategy** and incorporated to a certain extent within civilian-led programs:
    - For example, **launcher projects** are partly military-driven and have benefitted from continuous MoD support as launcher sites are essentially under **military control**.
    - The historical military lead of space affairs prior to AEB's creation and the pending **dual-use SGB mission** could re-affirm the clarification/need for a Brazilian space defense strategy, within an increasingly **civil security framework**. The involvement of the Defense & Security division of aerospace company Embraer in SGB also serves to bolster this growing domain.
    - Amidst the wider militarization trend Brazil is undertaking, particularly with respect to ensuring regional border control and to become a permanent member of the UN Security Council, a **national space defense strategy could** therefore **become more visible** in the future, through implementation, potentially within a new space agency framework.

Government Expenditures

Funding strategy

- From 1997 to 2007, Brazil's national budget averaged R$ 150million (C$108 million), essentially **influenced by EO and launcher program developments**. The 2000-2003 dip in the budget was linked to a major setback caused by a rocket explosion from the Alcântara Launch Center, killing 21 technicians. However, Brazil successfully launched its first rocket into space in 2004 and overall funding resumed, **nearly tripling between 2004 and 2010** to R$283million (C$150million).
- Based on announced budgets for the **2012-2015** period, **further peaks are foreseen** by as much as 57% between 2011-2015. If implemented, the 2012 budget should already more than double funding to R$788million (C$392 million) compared to 2011. These significant increases are driven by the AEB's long term strategy and clearly laid out budget plan. In addition, financing for the satcom dual-use system (SGB) is provided for elsewhere: in the 2012-2015 Federal Multi-Year Plan.
- The main strategy behind this substantive funding drive is to continue developing flagship programs and to turn planned projects into operational realities. To achieve this, Brazil is relying on:
    - Investing into the **expansion of the space workforce** through better recruitment and education programs to ultimately enhance national technological human resource skill sets.
    - Having recourse to **dual-use/shared practices** and a possible PPP funding model for the SGB program.
    - Considering a **merger** between INPE and the space agency **to centralise and consolidate** national space priorities.

Funding trends by programs

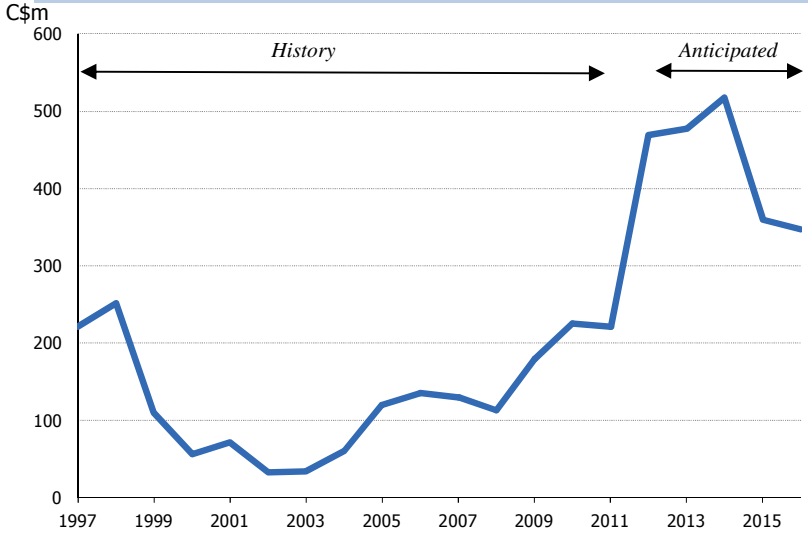
•National space funding is **almost exclusively civil related**; there is little space related defense funding asides from a steady R$2-4million/year worth of funding (averaging C$1.7million/yr over 2000-2010), mainly linked to launch centre operations and building human resource capacity (space expertise).
•The Ministry of S&T is tasked with providing funds to AEB and INPE to undertake all civil space activities. However, owing to the large costs of the future potential dual-use Satcom system (SGB), defense funding combined with private sector contributions could surface in the coming years, notably in the form of a PPP. In parallel, Brazilian telecommunications regulator Anatel, has also been **generating important government revenues** from the auction of 4 of its 8 orbital slots.
•Future funding should continue to be **sustained through to 2014**, after which an important number of missions will have been deployed and launcher milestones are expected to have been achieved. The government expressed its desire to triple the space budget as of 2011, without however mentioning a target timeline.

Key investment areas

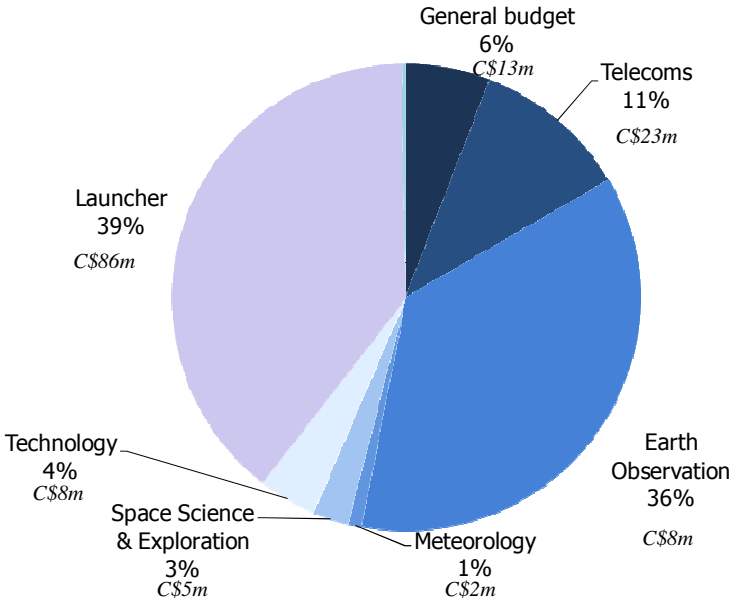
•**Launcher** activities have **dominated** Brazil's space activities for the past 15 years, at a gradually increasing pace (8% CAGR since 2006, to R$146million (C$89.09million) in 2011). Set within a long term vision of having an autonomous launch capacity, 2 programs have been funded in parallel, both relying on foreign cooperation: SCW and Alcantara Cyclone Space. Half of the total projected Alcantara costs (C$500 million) have so far been spent.
•EO funding comprises multiple programs (totaling R$2 billion (C$993 million) and was the 2nd largest investment area in 2011, with R$135 million (C$80m).
•A general budget of R$22million (C$13million), or 7% of the total budget, enables the coordination of a multitude of other activities related to the overall R$3.3 billion (C$1.96 billion) programs requiring long term funding, including preparing for growth opportunities.
•Although Satcom has not officially been at the forefront of AEB or INPE's priority, it is expected to take on a more prominent role in the coming years with SGB.

Brazil
Government Expenditures

BRAZIL SPACE EXPENDITURES 1997-2016



BRAZIL 2011 BUDGET : TOTAL: C$ 222 MILLION



Brazil
Industry policy

Profile of the national space industry

•Brazil has the largest economy of Latin America and has a **thriving aerospace industry** made up of 50 registered members of the industry association, mostly aeronautical-centric companies.

•Space turnover is estimated to total C$66million/yr (<1% of total aerospace revenues) thanks to around 20 companies being directly connected with space activities, mainly from the hardware/defense side .

•**Embraer** recently entered the space segment by winning a C$700million contract for managing the logistics and supply chain of the SGB development, under a **joint venture (BR1Sat)** with telecom operator Telebras yet to be formally created.

•The country implements the most advanced space program in Latin America, employing **3,400 people**, either in governmental agencies or industry.

•The Sao Jose dos Campos (**Sao Paulo**) **area** concentrates Brazilian space technology know-how, including INPE, the CTA and affiliated institutes as well as industrial companies.

Industry policy

•**Manufacturing and operating space systems domestically** has been a long-standing principle of the PNAE, drawing on its strong aerospace industry.

•Even though domestic capabilities are sought as a priority, **bilateral partnerships** have largely been used **to access new industry areas**, from China for CBERS to Russia/Ukraine for launchers and partnering with leading space agencies for EO/technology instrumentation developments. Gradually, foreign assistance reduces: 80% of 2nd generation CBERS system is all Brazilian.

•Due to the government's tight timeframe for implementing SGB, foreign vendors will be used to procure SGB-1; Embraer and Telebras, two leading but originally non-space players will create a joint venture to manage the procurement and **ensure skill-sets are retained**.

•This will make SGB-1 as Brazilian as possible while enabling the diversification of activities notably for Embraer, as set out in its Defense & Security business plan, responding to both the PNAE and the National Defense Strategy to support the **strengthening of domestic industry**.

Brazil space industry: key data

	Lead companies	Revenues (C$m/yr)	Jobs
Satellite systems and equipments	Ael Sistemas ; OMNISYS	28.8	Total 3400
Launchers (manufacturers)	Akaer Engenharia; Avibras	10.3	
Ground systems and services	Orbisat da Amazônia Indústria	27.7	

Source: estimates based on Aerospace Industries Association of Brazil; OECD

Challenges

•To implement the PNAE objectives under the ambitious funding goals necessitates **greater academic and industrial participation**. However, the interaction between current INPE and possible private sector involvement has not been unanimously approved due to concerns that private sector contractors could supplant the public sector workforce .

•**Federal approval** towards mergers (ABE/INPE) and the SGB Joint Venture project management company is also **taking time**, potentially affecting the timely realisation of the country's space goals.

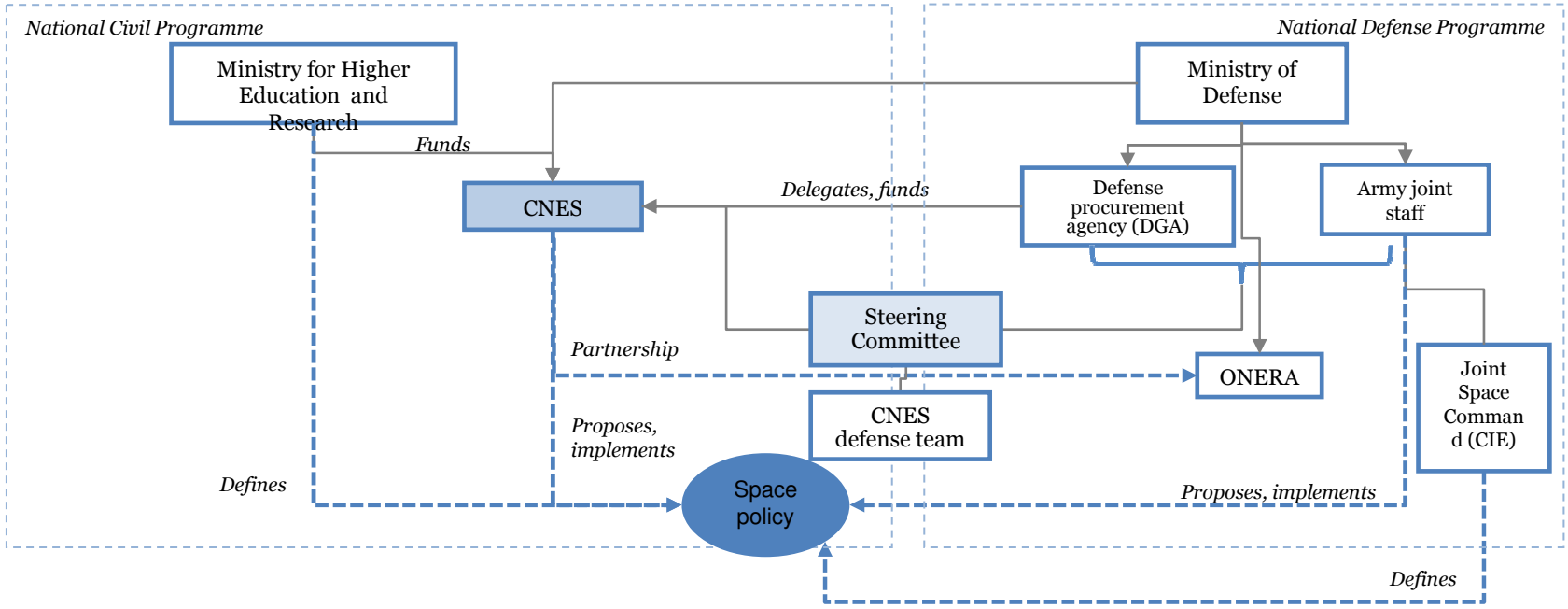
•In parallel, one of the key ongoing domestic challenges is linked to the availability of **skilled labour force** required to promote sustained growth and meet the ambitious space program goals, particularly for launcher developments.

•Launcher developments are in fact affected by foreign **partners' funding & delivery abilities** to meet Brazil's targets – a feat encountering difficulties partly due to the global economic recession, stretching funding sources.

Governance of the national space program

Outlook of key government stakeholders and decision making

- Founded in 1961, the Centre National d'Etudes Spatiales (CNES) is the government agency responsible for proposing, shaping and implementing France's space policy. Its principal objective is to develop space applications to meet the civil and defense needs of government authorities, and the needs of the scientific community. CNES is also the contracting authority for the programs entrusted to it by the Ministry of Defense.
- CNES is under the double supervision of the Ministry for Higher Education and Research and the Ministry of Defense, which reflects the **long history of cross-support between military and civil space programs** in France. The agency manages the « dual research » component of its space program via the orientations and recommendations of a « **Piloting Committee of the Defense Team** » to take into account defense priorities continuously. The Defense Team comprises 6 persons: 2 officers from the Army joint Staff (EMA), 2 engineers from the Defense procurement agency (DGA) and 2 from CNES.
- The Ministry of Defense established a **Joint Space Command in 2010**, to propose a defense space policy, define the need for space capacities, and to contribute to their acquisition. This organization coordinates the use of France's defense space assets and acts as a referee among the different services.
- The Defense procurement agency (DGA) takes control of the defense satellite systems when they become operational.
- The National Office for Aerospace Studies and Research (ONERA), reporting to the MoD, conducts aerospace research. It signed a partnership agreement with CNES in 1998.



Space policy and strategy outline

National Space Strategy

- The main objective of the French space policy, as formulated in a 2008 presidential statement, is to **master all aspects of space**, from end to end, and to **drive the development of the European space sector**.
- A multi-year contract between the French government and CNES specifies the orientations of the French space policy. The first contract (2005-2010) was signed by four ministers (from research, defense and budget), and the president of CNES. It was renewed for the 2011-2015 period. This contract :
    - Contributes to the emergence of the EU as a major player in the European space policy and works for the advancement of the Galileo and GMEs programs
    - Implements new space systems, alone and through international cooperation. International cooperation is a key issue given the current budget constraints.
    - Strengthens the expertise of CNES for the development of new generations of satellites and launcher systems, with help of funds made available from a public bond issue in 2011.
    - A strategy paper published by the ministry of research in March 2012 reiterates these objectives , and pleads for an increased role of the EU in space.

ESA programs

France wants to maintain a leading role in Europe but lost its place of first contributor ESA against Germany in 2012.

•Launchers: **autonomous access to space is the cornerstone of French space policy**. France has played a leading role in the Ariane program and is now closely involved in ESA's ARTA program to maintain the reliability and quality of Ariane-5. France supports the development of Ariane 6 and is engaged into a strong debate with Germany whether Europe should invest in a new generation rocket,

•Earth observation: France is significantly involved in the development of the GMES space component, the Sentinel satellites, which are being manufactured by Thales Alenia Space and EADS Astrium. CNES provides expertise for Sentinel 2 and 3 (monitoring of compliance for image and altimetry quality). Additionally, France has been the most significant contributor to the EO Envelope Program for the past 15 years (16% of the EOEP budget) dedicated to studying climate change & Earth science.

•Science and exploration: the French space science program is essentially pursued via ESA, with instruments supplied for Cosmic Vision and Aurora programs. However, the French government was the only one to vote against the continuation of Exomars in 2011 and to refuse new spending until the mission is better defined.

CNES programs - National activities cover 5 "strategic areas" :

• Access to space: Under ESA contracts, CNES operates, maintains and upgrades the Kourou launch base. Since 2008, the French agency has been the control authority for orbit insertion and maintenance. It provides technical assistance to ESA for the Ariane-5 programs and conducts national R&D to prepare future technologies.

•Earth observation: CNES has historically been involved in climatology missions and now focuses on the development of capabilities in ocean topography and altimetry. The continuation of the SPOT series has been transferred to the private sector in 2008.

•Satcom: Multimedia and mobility are future priorities at national level. An initiative of the stimulus plan is to revisit the design of existing GEO platforms to support the competitiveness of the space industry by reducing the cost of delivering a MHz by about 30%.

•Science and exploration: CNES activities essentially focus on small satellites based on platforms developed as part of the Research and Technology program. The agency also cooperates with international partners for space science missions.

•Dual use and security: CNES conducts dual research, as part of its dual-use heritage since it is overseen by Research and Defense ministries. CNES's defense team works to exploit the benefits of civil programs for defense applications. France currently develops two Earth observation (Pleiades) and one communication satellite (Athena-Fidus, in cooperation with Italy) as dual-use programs.

Defense programs

- The French defense space policy is defined by the 2008 « White Paper on Defense and Security », which supersedes the one issued in 1994. Space features prominently, with a central role to play in the main defense functions. Previously, the prospective long-term plan (PP 30) also put forward the strategic nature of space.
- High priority is given to the « knowledge and anticipation » function, which represents the first line of French Defense.
- Besides ensuring continuity and modernization of its current space assets, France will put efforts in four areas: Ultra-high resolution; ELINT; Early warning; Space surveillance.
- The creation of the Joint Space Command in 2010 illustrates the importance of space for defense and national security.
- France has Europe's largest defense satellite program with national satellite communications and surveillance capacities. It had long pushed its European partners to embrace cooperation but, in front of the difficulties to find appropriate cooperation schemes, it decided to renew its capabilities on a domestic basis (with small contributions of other European countries).
    - **Telecommunications**: Two Syracuse-3 satellites have been providing France with EHF capabilities since 2005. The system is being continued in bilateral cooperation with Italy, as France will place a satcom payload on the upcoming Sicral-2 satellite. The objective of the French MilSatCom program is to implement two types of communication networks: 1) robust and highly secure networks with Syracuse-3
      2) Less-secure, but higher capacity networks with the dual-use Athena-Fidus

      Following the British example, the French MoD had plans to privatize its MilSatCom system through a sale and leaseback formula. However, these outsourcing plans were scrapped in early 2012 due to ownership and control concerns. For future programs (around 2020), France clearly favors a partnership model with other European countries, possibly through a Public Private Partnership.
    - **Reconnaissance:** France made the choice to invest in optical capabilities with the Helios system, now in its second generation. Access to radar data is possible through agreements with Italy and Germany. In addition, the MoD will have access to the Pleiades dual-use satellite, mostly funded by CNES. DGA will have a right of « preferential use » of data if required. The Helios succession is the priority of the French space defense program. It will be done as part of the European MUSIS initiative, for which France will supply the optical component.
    - **Other capabilities**: The development of new defense capabilities is put forward in the 2008 White Paper, to face new threats (terrorism of mass destruction, ballistic missile proliferation…). France is the only European country to fund R&D in view of acquiring operational capabilities in ELINT and early warning. It is decided to finance alone operational ELINT satellites, as this project aroused little interest from other European countries.

Government Expenditures

Funding strategy

- France manages the largest European space program with a total of €2.24 billion in 2011 (C$3 billion), split between civil (83%) and defense (17%) activities.
- After a **17-year period of stability**, the budget increased by 5% in 2011 under the combined effect of increased allocations to the national program and more funding to ESA, while the defense budget decreased.
- French former President reaffirmed in 2011 that the space budget should be maintained despite pressures on public spending, given its essential stake for sovereignty. However, choices must be made in the context of limited financial resources.

Funding trends by programs

•French contributions to ESA were stalled at €685 million (C$1 billion) per year over 2005-2010 by the first multi-year contract between CNES and the government. This caused a debt vis-à-vis ESA, as the agency's called-up contributions exceeded that amount. The new budget contract signed with the government provides more funding to ESA until 2015, for debt repayment. However, France recently threatened not to fund the next EO Envelope Program 2013-2017 due to Earth government-wide science budget cuts – a decision should be made in November 2012. Launchers remains the first area of spending for ESA programs, in line with the attachment of France to European independent access to space.
•The national civil space budget is essentially driven by launchers (due to CNES's involvement in the Guiana Space Centre), Earth observation and technology. After a stable period over 2006-2010, it rose by 13% in 2011 and will be supported in 2012 by extra-funds from the stimulus package.
•The defense space budget experiences a downward trend, in a transition phase before the renewal of existing systems and the acquisition of new capabilities.
•Growth of the space budget is expected in the next few years, driven by ESA for debt repayment and defense for a new development phase. The national civil space budget should stabilize until 2015, according to forecasts of the current multi-year contract.

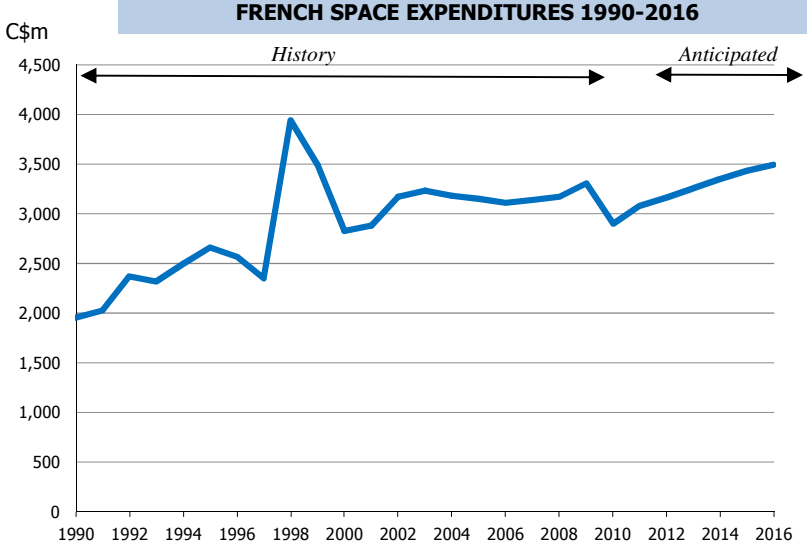
Key investment areas

•Launcher is the first area of spending, accounting for one-third of the total space budget in 2011 and 40% of the national civil space budget, largely due to ESA contracts related to the Guyana Space Centre. Considering only the government funding, the share of launch vehicles in the national budget reduces to 14%. Funding for launchers-related activities has remained constant over the years.
•Earth observation is the second area of spending, accounting for 13% of the national civil budget and of the contributions paid to ESA. After three years of stability, the national budget started to increase in 2010 and now surpasses funds allocated to ESA that have stabilized. With a diversified program, France intends to play a key role in GMES.
•Satcom funding is dominated by the defense program, which represented 64% of total expenses for this application in 2011. Civil spending is equally divided between ESA and the national civil program. Investment in Satcom has decreased by almost two-thirds in five years due to the completion of the military Syracuse-3 program.
•Other areas (science, technology and manned spaceflight) each account for less than 10% of the total space budget. Science is mainly conducted through ESA with slightly increasing budgets in relation with space exploration funding. On the opposite, technology is almost entirely funded by the national program. The R&T program is considered vital to prepare for future projects, develop national expertise and make technology breakthroughs. Funds are slowly, but constantly increasing.
•The general budget accounts for around 15% of CNES funding. The agency employs 2,400 persons.

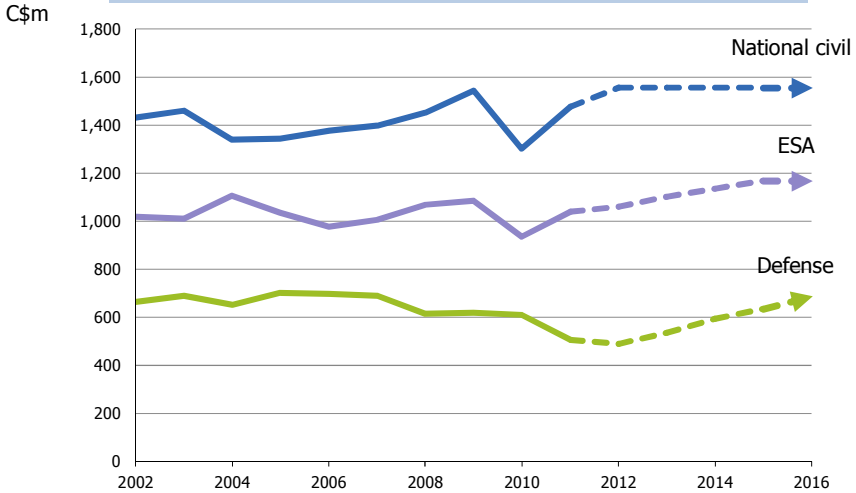
France

Government Expenditures

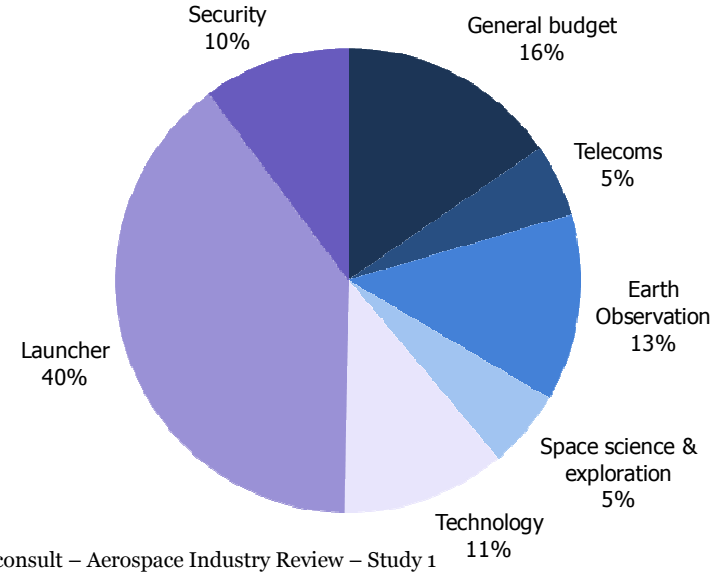
FRENCH SPACE EXPENDITURES 1990-2016



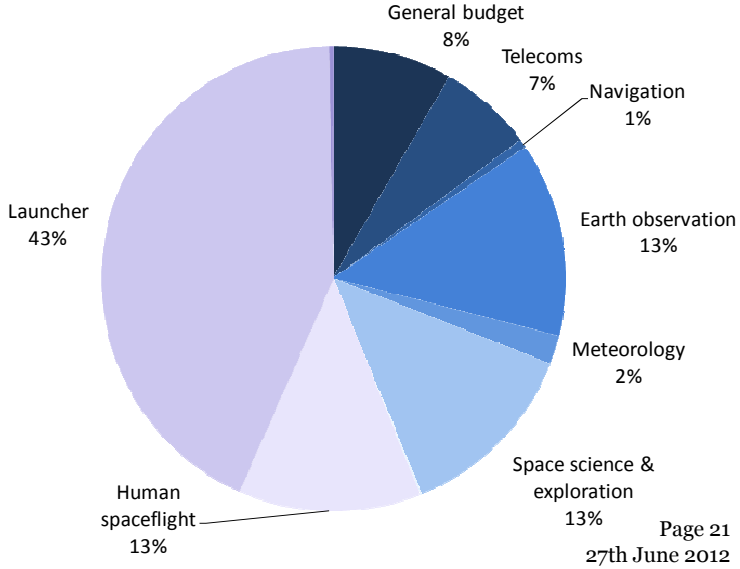
SPACE EXPENDITURES BY PROGRAMMES : 2002-2016



CNES 2011 BUDGET : TOTAL: C$1.4 BILLION



ESA 2011 CONTRIBUTION: TOTAL: C$1 BILLION



Industry policy

Profile of the national space industry

- The French space industry is by far the largest in Europe, as a result of the pioneering role played by France in the development of space technologies, particularly for launchers.
- According to statistics of GIFAS (the French aerospace industries association), revenues amounted to €4.2 billion (C$6.3billion) in 2010, down 3% from 2009. They were split between civil (82%) and military activities (18%). Exports accounted for 51% of revenues.
- The French space industry employed 13,000 persons in 2010.
- France hosts the largest space actors in Europe, both for satellite systems and for launchers. Most of them are part of large industrial conglomerates from the Defense or Aeronautics sectors or from the global industrial sector. There are very few small independent space players in France.
- In addition to the two large European satellite integrators, Thales Alenia Space (TAS) and Astrium Satellites, the French space industry comprises several important players of the international satellite equipment market.

Industry policy

- CNES is especially attentive to maintain industrial competencies and has a "swarming policy" to transfer new technologies to industry. The national space industry is actively supported by CNES's R&T program.
- The Stimulus Plan supports the development of new technologies for launchers (€500 million (C$642.9 million) for Ariane-6), platforms (NGP for satcom and Myriade Evolution for EO and science: €42.5 million (C$54.7 million) and €40million (C$51.4 million), respectively) and Earth science (SWOT with NASA, with €170 million (C$218.6 million).
- CNES's activities in telecommunications aim at sustaining a competitive satellite industry for buses and payloads integrated by Astrium Satellites and TAS. Platform development is supported by two programmes:
- Alphabus, as part of ESA's ARTES-8, for large and powerful satellites (>6T; 18kW)
- The "New Generation Platform" (NGP) project of the stimulus plan intended to revisit the design of the existing Eurostar and Spacebus series and boost the competitiveness of TAS and Astrium on the segment of 3 to 6-ton satellites.

French space industry: key data

	Main companies	Revenues	Jobs
Satellite systems and equipments	Astrium Satellites; TAS France; Saft; Sodern	€4.2 billion (C$6.3 billion)	13000
Launchers	Astrium ST; Safran; SNPE; Arianespace		
Ground systems and services	Eutelsat, Astrium Services; TAS France; In-Snec		

Source: GIFAS

Challenges

• As commercial programs account for an important share of the French space revenues, the forecasted lower cycle on the commercial satcom market will have significant consequences on the revenue growth. It is not expected that institutional revenues will offset this negative impact given the current funding constraints.

• Astrium ST, the Ariane-5 prime contractor, must ensure the launcher's self-sufficiency , a prerequisite for the development of the Ariane-5 ME version. The production chain should be rationalized in view of the next generation vehicle, as no public funds would be required for its exploitation.

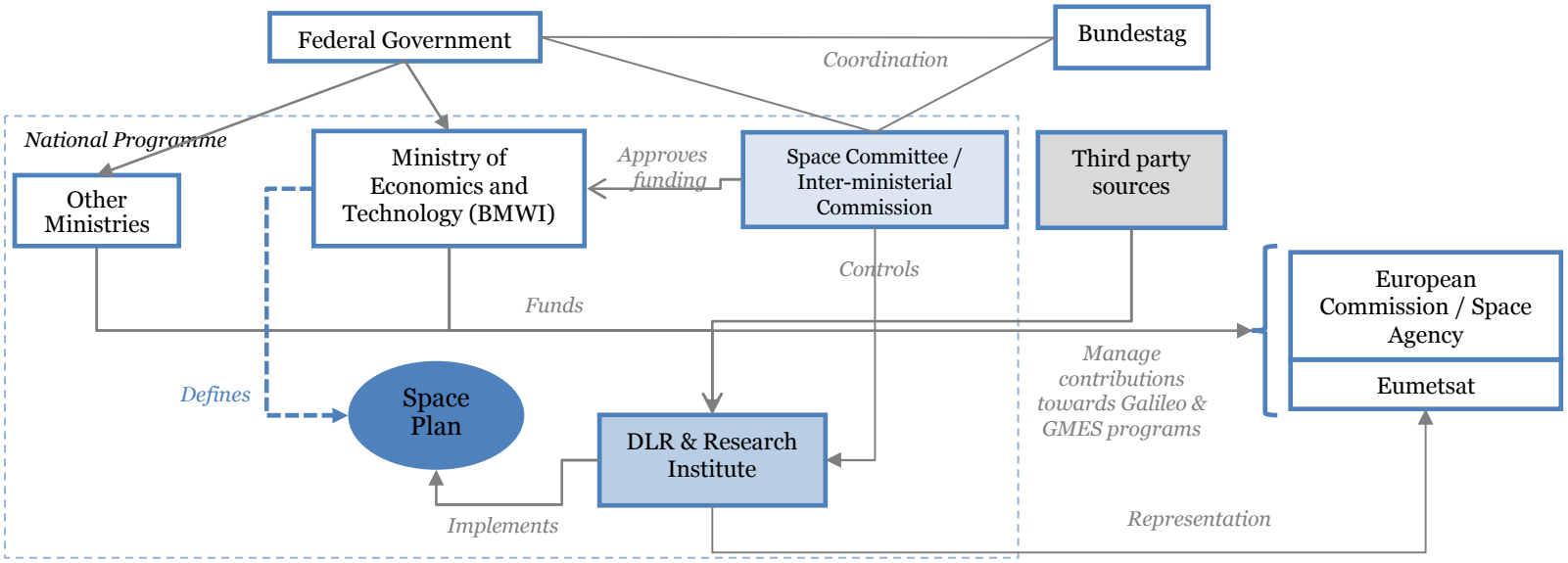
•Technological developments must be made , both on solid and liquid propulsion, in an efficient way. Future evolutions of the launch market must be anticipated in order to meet the demand.

Governance of the national space program

Outlook of key government stakeholders and decision making

- The German national research center for aeronautics and space (DLR) is the government agency responsible for managing the national space program. DLR draws up aerospace projects for the federal government and carries out aerospace programs.
- Space matters used to be supervised by the Ministry of Education & Research until 2005 **when it was decided to shift this responsibility to the Federal Ministry of Economics and Technology (BMWI)** as part of a new strategy to focus the national space program on industry and market issues, The Education & Research Ministry (BMBF) still holds some responsibilities related to space R&D.
- Other Federal ministries can be in charge of specific activities reflecting a common practice in Europe: the Ministry of Transport, Building and Urban Affairs (BMVBS) managing Germany's contribution to the Galileo, GMES programs and Eumetsat (effectively acting as users for the programs); the Ministry of Defense (BMVg) for military EO and Satcom operations, assisted by the Office of Defense Technology and Procurement (BWB) reporting to the Directorate General of Armaments. The Ministry of Foreign Affairs participates in international negotiations. A parliamentary Secretary of State to the BMWI acts as a coordinating body to ensure coherent governance amongst these ministries.
- The Parliament (Bundestag) approves funding to DLR on an annual basis. It has a **permanent committee on space** which manages several aerospace working groups. **Some frictions can occur between Federal bodies**: this was notably the case when the Bundestag refused to fund a national lunar robotic program. This resulted in strengthening international cooperation in space exploration, and bilateral cooperation across other applications.

•**Provinces (Länders) are also been involved in space** related issues especially with respect to regional strategies and funding of local initiatives. Landers for instance contribute to project financing: the Land of Brandenburg contributed €37 million (C$47.5 million) to the RapidEye project while BMBF contributed €14.7 million (C$18.9 million).



Space policy and strategy outline

National Space Strategy

- Since the early 2000s**, the German government regularly revises and releases its national policy** for space in official papers:
  - In 2001, a 4-year national space plan (**the first since the early 1980**) redefined German space policy, with a new focus on space applications with potential commercial developments and direct benefits to society, it was revised in 2005,
  - In 2010 the German Federal Government adopted a new Space Strategy at its cabinet meeting, **The Strategy was prepared at Ministry level** by BMWii with contributions from other Ministries and in consultation with scientific and business stakeholders, including DLR,
- The Strategy, in continuation of the objectives of the 2001 and 2005 Plans, focuses on **supporting a competitive national space industry and the development of market oriented innovation programs,** In particular, it articulates 5 key thematic areas
  1. Expand the strategic space expertise by developing selected key technologies and a domestic know-how in science, EO, communications, navigation and robotics (SAR, broadband, laser communications, ground segment, exploration robotic technologies etc,),
  2. Reinforce its position in space research, through ESA, national and bilateral space missions
  3. Enter new markets, strengthen the German share of the global commercial space turnover and support the growth of commercial space applications
  4. Improve the legal framework to support the private investments in the space business (Satcom BW, TerraSAR, RapidEye,,,)
  5. Space Security activities, notably by mastering the key dual technologies, developing synergies between civil and military research and protecting dual systems.

ESA programs

Germany increasingly sees its participation to ESA activities as a key tool to develop the capabilities and competitiveness of its national industry (as shown by its growing contributions). Four main programs dominate Germany's involvement in ESA :

- Earth observation: focusing on the GMES space component development
- Science and Exploration, represented the core focus of its participation, now with the objective to leverage the scientific and robotic capabilities developed by the national industry
- Manned spaceflight: also a past focal point of German participation, now focusing on making full use of the ISS potential,
- Satcom: motivated by supporting the upstream industry, propelling OHB in the SGEO platform development
- Launchers: Germany is an historic contributor to the Ariane program, now debating with France on the launcher next generation, favoring an upgrade version of the current Ariane 5 model to the development of a new launch vehicle generation.

DLR programs Germany's space activities are divided into 3thematic areas (Earth, Space and ISS/infrastructure) of which these are the main strategic areas:

- Observation: 1st priority at national level, leverages on scientific and dual use missions to bolster upstream capabilities and maintain leading role throughout the value chain, from data commercialization of government systems (e.g. Infoterra) to delivering science-based products for public users.
- Science & Exploration: supports large number of research institutes (e.g. Max Planck Institute), collaborating bilaterally and internationally (ESA, NASA), focusing on astrophysics, solar system research and fundamental physics
- Technology: leveraging on a strong heritage in robotics developed with Russia and Canada (e.g. Rokviss manipulator), programs have been widening since 2008 to other technologies (e.g. cryogenic upper stages, demonstrator platforms, servicing mission DEOS).
- Satcom: develop niche technologies, largely driven by R&D, to become industry leaders (e.g. inter-satellite laser communications)
- Navigation :supporting local small businesses to enter the global navigation market with innovative applications, e.g. development of Galileo Test Bed.
- Human spaceflight: strictly focusing on channeling its various science institutes' expertise areas through the ISS exploitation at ESA level.

Defense programs

•The German government has initiated in the late 1990s **a throughout military reform**, with a complete review of the Bundeswehr policy, organizational structure, objective, procurement and equipment. One of Germany's particularities is to integrate **space assets as part of this reform**. The shift of the Bundeswher's objectives and missions from border protection to a more proactive cooperation in overseas operations has implied new requirements in terms of equipments including space.

•**Space systems have become a real political and military issue** following the crisis in the Balkans in the 1990s. Over-dependance vis-à-vis foreign systems (in particular American) has been highly criticized and pushed German authorities to reconsider the place of satellite assets in military overall equipment.

•In line with Germany's defense policy, space systems are more considered for their **strategic function in crisis management** missions and collection of data in support to political decisions, than for an operational use during military operations. This is why Germany decided first to develop Sar Lupe, and how the government justified the necessity to develop the system. Nevertheless, the decision to implement a communication satellite system (Satcom Bw) reflects the recognition of the increasing use at operational level of satellite systems.

- **SAR LUPE**: Sar-Lupe consists in a constellation of five small high resolution satellites providing the German Armed Forces with independent reconnaissance capabilities below the 1m range. TerraSAR-X/Tandem-X satellites are also used by German Armed Forces. Germany considers Sar-Lupe a contribution to a future European reconnaissance network, supporting the EU security policy. Cooperation with France represents an initial step in this regard through the inter-operability of SAR-Lupe and Helios 2. Germany is a partner in MUSIS, the future European space-based imaging system. OHB is now studying a successor – SARah – that would feature higher resolution and a faster response time. Germany has also been reported to consider a military cooperation with the US as part of the High-Resolution Optical System (HiROS) project. However, the three-satellite project is still awaiting approval by the German parliament.

- **SATCOM BW**: Following the examples of the UK and Spain, the German MilSatCom program is privately operated by MilSat Services (a company owned by EADS Space Services and ND SatCom, an SES subsidiary). However, contrary to its British and Spanish counterparts, the German government has decided to retain ownership of the system (via the Federal Office for Information Management and Information Technology of the Bundeswehr, IT-AmtBw). In 2006, a 10-year contract worth €939 million (C$1.3 billion) was awarded to Milsat Services. COMSATBw plays an important role in the Bundeswehr's concept for network-centric operations, providing services over a region stretching from the Americas to Eastern Asia. It allows voice and fax, as well as advanced data, video, and multimedia applications. Germany is the fifth European country with a dedicated secure military communications satellite network.

Germany
Government Expenditures

Funding strategy

- After a **15-year period of stability**, at around €700–800m (C$ 1.03 -$1.18 billion) per year, Germany's investment in space started to rise in 2007 under the combined effect of the civil and defense programs
- Since then its **space expenditures has experienced significant growth** (+40% in 5 years) reaching €1.4billion (C$1.8 billion) in 2011, split between civil (91%) and defense (9%). This growth was not related to the €50 billion national stimulus package but rather a continuation of the strategy implemented since the early 2000 to develop the national space industry recognized as a priority technological sector.
- Germany's strategy has been guided by **strengthening R&D** at national level through DLR and **reinforcing its position within ESA** with regular increase funding, The government also promotes PPP funding mechanisms for defense procurement and market oriented programmes.

Funding trends by programmes

•Contribution to ESA has regularly increased over the years (€714 million (C$980 million) in 2011) though it represents a lower share of the country overall funding in space. Human spaceflight, launchers and earth observation have been the primary areas of investments in ESA **where Germany sees it can get more leverage** than on a domestic level. 74% of EO funds are directed to ESA strongly linked with GMES development (Astrium & Jena Optronik in Sentinel-2),

•National civil programmes (DLR) have received strong push with 44% growth in 5 years (€536 million (C$738 million in 2011) as part of an overall **strategy to boost R&D** which represents over 60% of DLR.

•Defense spending was boosted from almost no/marginal investment in the early 2000's to €120 million (C$165 million) as of 2009, to fund **new capabilities in both satcom and reconnaissance capabilities.** The SatcomBW system represents an overall investment of around €900 m over a 10 year period. If HiROS goes ahead and SAR Lupe is replaced, military spending could increase further in the next few years.

•**The growth of the German space budget is expected to be sustained over the next ten years**, though probably at a slower pace. The ESA contribution should essentially benefit from this growth as the 2010 National Space strategy reaffirmed Germany's commitment to become the first European space player.

Key investment areas

•Earth Observation is the first area of spending essentially through ESA and DLR programmes, Following the development of **SAR capability**, the objective is now to master full manufacturing capability.

•Satcom has experienced a strong growth over the past years to €212 million (C$320 million) in 2010 driven by defence (47% of spending, Satcom BW) but also by a drastic increase in contributions to ESA to **support industry positioning** (Small GEO programme and EDRS), National R&D focuses on R&D for high bandwidth optical communications payloads and the development of a next generation broadband satellite (Heinrich Hertz) built on the Small GEO platform.

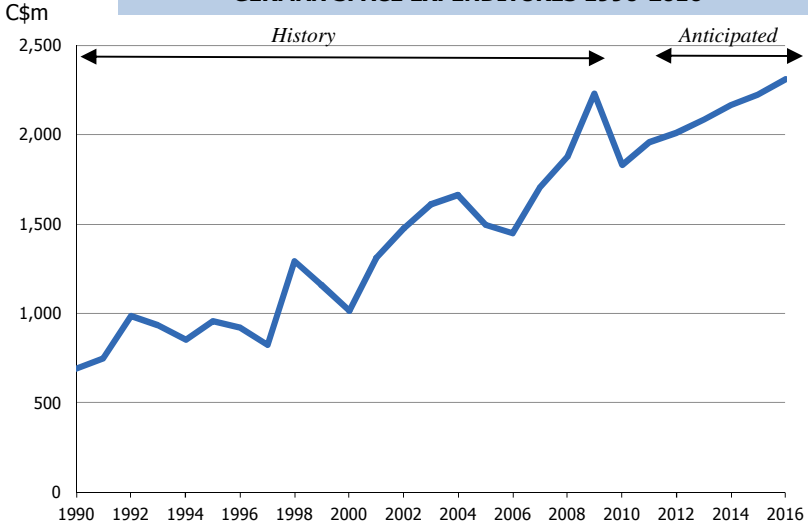
•Human spaceflight was a key focus of the German space program, **now less of a priority**, 90% of the €188 million (C$242 million) is spent through ESA for the ISS, now targeting scientific research onboard the station.

•Launch vehicles activities are dedicated to ESA representing 94% of the stable €100 million (C$129 million)spent each year. Germany manufactures Ariane 5 upper stage, DLR is participating to a **working group with CNES** dedicated to the evolution of Ariane and the preparation of next generation European launchers.

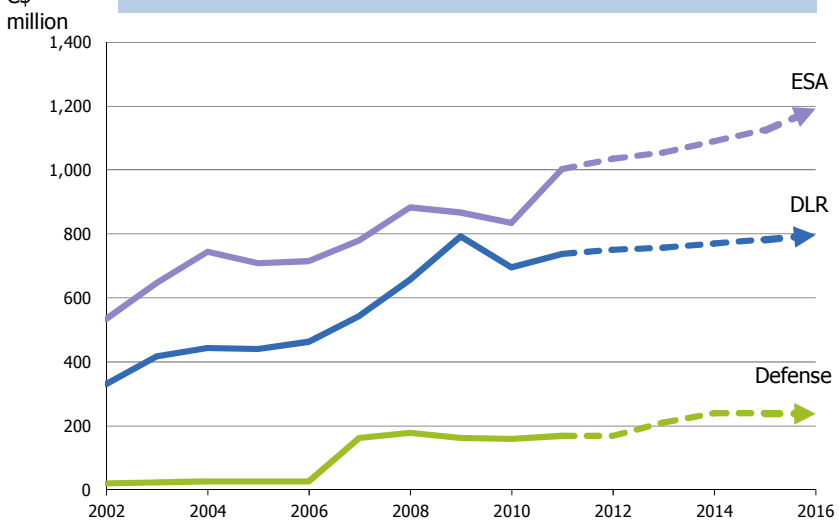
•Space science expenditure has remained stable over the years at around €130 million (C$167 million), **Contribution to the exploration programme is relatively new**. Germany has been pushing for a robotic mission to the moon within ESA. Around 30% of space science funding is spent on the national programme.

Germany
Government Expenditures

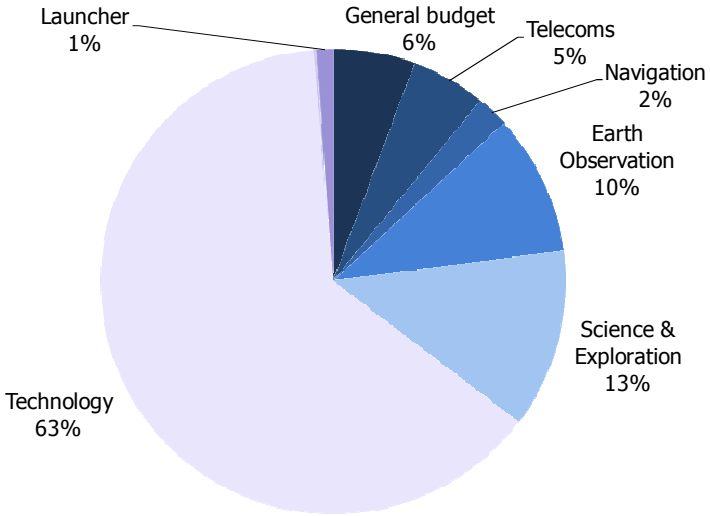
GERMAN SPACE EXPENDITURES 1990-2016



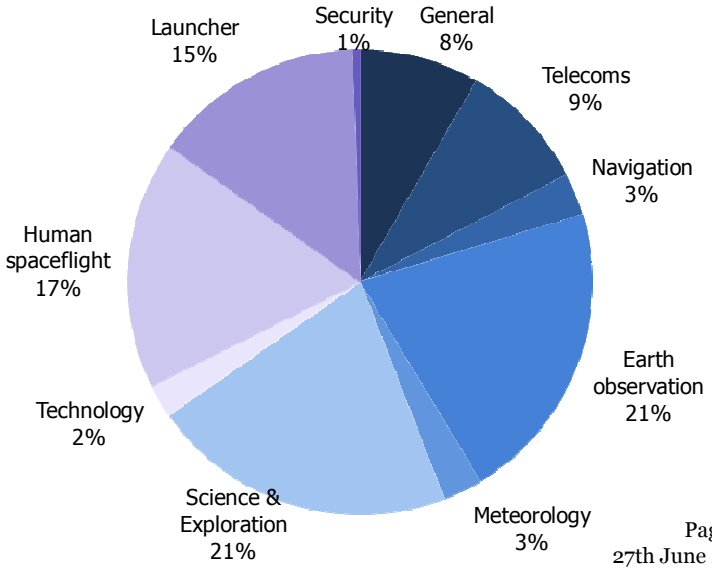
SPACE EXPENDITURES BY PROGRAMMES : 2002-2016



DLR 2011 BUDGET : TOTAL: C$738 MILLION



ESA 2011 CONTRIBUTION: TOTAL: C$980 MILLION



Primary data: BMWI, BMVBS, ESA

Germany
Industry policy

Profile of the national space industry

- Germany is home to the second largest space industry in Europe, generating €2.2billion (C$2.8billion) in revenues in 2011, up 3.7% over 2010. A total of ~7500 people worked in the space industry in 2011 (up from 6700 in 2010) across at least 1100 organizations, including >300 SMEs and >100 service firms.
- Spearheaded by 2 main industrial poles in the Bavaria and Bremen areas, a 3rd pole is planned, for reviving the historically strong science/industry Berlin-Brandenburg area.
- The German industry is well diversified across all segments of the space markets but technology capabilities focus on developing launchers and spacecrafts. Companies incorporate system-level prime contractors (e.g. Astrium), integrators (OHB) and numerous equipment suppliers that are generally highly dependent on their space business. The industry association BDLI provides trade support, ensuring that government investments are adequately managed to maximize revenue potential.

Industry policy

- The German space industry benefited from the increase in space R&D funding as part of the **2006 High Tech strategy**, which allowed the development of specific industrial capabilities such as the SGEO platform developed within ESA ARTES program.
- The strategy has led to promoting competition amongst national industry players, not only to maintain a technological leading edge but also to ensure the provision of optimized and cost efficient solutions downstream.
- National space industry growth has been largely driven by increased participation to European programs (ESA and the EU), with companies like OHB emerging as a new European champion following government support in key European contracts (SGEO, Galileo and MTG),
- The German space industry has also been dominating other European space infrastructure programs (ISS, ATV) following the strong political positions taken by Germany in these programs,

German space industry: key data

	Companies	Revenues	Jobs
Satellite systems and equipments	Astrium, OHB, Tesat, Azurspace, Jena-Optronik	€2.2 billion (2011) (C$ 2.8 billion)	7500
Launchers	RUAG, MT Aerospace		
Ground systems and services	Serco, Vega, Terman, Telespazio		

Sources: Eurospace, ESA, BDLI

Challenges

•Over the recent past, strong efforts have being placed around the OHB Group to establish a more commercially-oriented satellite industry in Germany (SGEO program in particular). Creating a 3rd industry pole is expected to help transform a high unemployment area into a successful innovation/industry success.

•A means to pursue national industry activities while minimizing government expenditure includes boosting PPPs and increasing industry involvement, as implemented for SatcomBW.

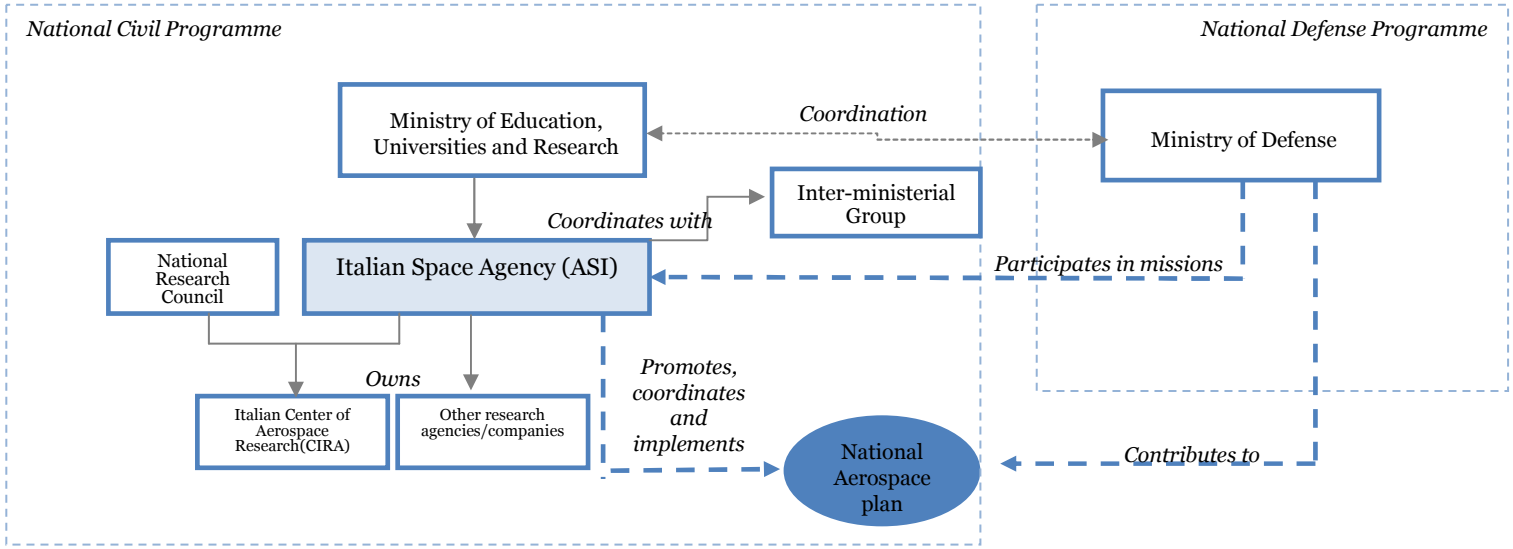
•Given the largely predominant share of institutional revenues, prospects for the national space industry are tightly linked to the evolution of national space budgets.

•In the mid-term, more challenging market conditions could lead to a relative market rationalization, and new consolidation moves with the integration of small space entities could be observed.

Governance of the national space program

Outlook of key government stakeholders and decision making

- During the 1960s, Italy was a key partner in the European Launcher Development Organisation and the European Space Research Organisation which later merged to form the European Space Agency in 1975. Space activities and funding were then split between the Space Activities Service of the National Research Council (which controlled national space activities) and the Ministry of Research (which coordinated Italian Space activities within the space exploration framework).
- The need to rationalize and strengthen Italy's position on space research resulting in the establishment of the Italian Space Agency (ASI) in 1988 to end the **dichotomy** in the control of space activities. ASI coordinates & implements Italian space policy and also has direct control of 3 operational centers in Italy & Kenya.
- In 2003, the Italian Government **restructured ASI** to optimize activities and promote, develop and diffuse scientific and technological research in the fields of space and aerospace. Its mandate also expanded to the coordination and management of national projects and include Italian participation to European (ESA and EU) and international projects. An additional push towards space was prompted by the election by the Council of Ministers of a new ASI president in 2009.
- Reporting to the Ministry of Education, Universities & Research (MIUR), ASI strictly **operates in coordination with the inter-ministerial group** responsible for governmental guidelines in aerospace. Members of the group are appointed by various ministries across education, research, foreign affairs, defense, industry, transport, communications and the environment.
- The Ministry of Defense is in charge of the space component of Italian defense activities. Favoring cooperation, either at national or bilateral level, it cooperates with the Ministry of Research and with the French defense missions to streamline space operations dedicated to national security and avoid duplication.



Space policy and strategy outline

National Space Strategy

- Since the election of a new president in 2009, the Italian Space Agency (ASI) policy has been strongly **promoting space**, which is seen as a means to attract the young to scientific carriers and to develop international relationships. In late 2010, ASI published a "**Strategic Vision 2010-2020**" with the following guidelines:
    - Maintain and strengthen scientific knowledge through the development and launch of key scientific instruments and analysis of the data they provide
    - Achieve a global leadership position in earth observation
    - Support national security objectives
    - Foster independence and profitability in Italy's national telecommunications infrastructure
- To reach these objectives, ASI will give **priority** to dual-use programmes and intends to rely increasingly on private industry through **public-private financing** schemes. The agency will foster existing areas of national competence (propulsion, science and earth observation payloads) and develop new ones, without duplication of capabilities already available in Europe.
- Furthermore, the **National Research Program 2011-2013**, adopted in 2011, confirms the strategic importance of Earth observation and telecommunications with the support of three new projects in these areas: namely, the COSMO SkyMed II Generation, high resolution satellites for earth observation, an optic satellite for remote sensing and Sigma, a satellite-based communication system to be applied in the field of defence and public administration. The plan is broadly welcomed and though partly funded from the national research fund it has raised some criticism as it largely relies on the research centres' own resources, thus limiting their funding capacity for ordinary research.

ESA programs

- **Close cooperation** with ESA will be maintained, with half of Italy's space activities dedicated to major ESA programmes where qualified roles and substantive returns for Italy are assured. Cooperation with European and world leaders in space activity is also strengthened through other international agreements.
- Launchers is the 1st area of Italian spending in ESA programs with the development of Vega. ASI is now committed to the **evolution** of Vega through ESA's VERTA program and national LYRA initiatives. Italy is also involved in the **Ariane-5 program**, with main contributions on solid boosters and the first stage turbo pump.
- ASI participates in deep space exploration through ESA's Cosmic Vision program and has a leading position (40% share) in the AURORA exploration program.
- Manned space flight is a primary area of investment for Italy who has contributed to the International Space Station both at a national level and via ESA. The program now aims at optimizing the International Space Station exploitation in terms of scientific research and supporting human exploration.

ASI programs

- COSMO-SkyMed, a dual use system of four high-resolution SAR satellites launched between 2007 and 2010 is at the **heart** of the national program. The next priority of the Italian Earth observation program will be COSMO-SkyMed Second Generation, to ensure continuity after 2015 and improve capability.
- To **enlarge capabilities** beyond radar, Italy is conducting an optical satellite program consisting of at least two mini-satellites. PRISMA will carry a hyperspectral sensor, possibly paving the way to future operational missions and MIOSAT will contribute to boost the industry operating in microelectronic components and micromechanics. A third project is supported by the national research program.
- Since the end of the Italsat program in the early 2000s, Italy has no domestic SatCom system. Italy's strategy is now to develop its own civil/dual use infrastructure, to gain independence. This infrastructure will **comprise three elements**:
    - Athena Fidus, a dual use broadband program conducted with France. The satellite entered development phase in 2010, for launch in 2013/2014
    - KU-band capacity purchased from Eutelsat and SIGMA, a domestic dual use satellite in Ku/Ka band

Defense programs

•The Italian strategy regarding defense Earth observation was **to join ASI** in the development of COSMO-SkyMed instead of developing a dedicated system, to provide continuity with the French Helios (Italy contributed 14.1% of Helios-1).

- •Cosmo-SkyMed is used by the MoD for space based intelligence, surveillance and reconnaissance (ISR).
- • The COSMO SAR allows difference performance in terms of swath dimension, spatial resolution and polarization. The second generation, to be available starting 2016, will ensure continuity of the system and improve its capability in terms of imagery production and resolution.

•The Italian MoD **procured Sicral** satellites as Italy's domestic defense space communications system in 2001. The two satellites operate on UHF, SHF and EHF/Ka-band (with the possibility to switch on board) to support strategic and tactical communications on national territory and on operations in foreign areas, as well as mobile communications with land, sea and air platforms. Sicral 1B, launched in 2009, was **specifically designed** for interoperability with civil emergency networks, in line with Italy's concerns on the management of emergencies. The Sicral program benefits from financial support of the Ministry of Economic Development, as part of its industry competitiveness and high technology initiatives. This ministry paid €103 million (C$158m) for Sicral 1b, and €80 million (C$123m) were provided by Telespazio in exchange of one-third of the satellite capacity.

•The **construction contract** for Sicral 2 was placed in May 2010. The program is expected to cost €370 million (C$570m), including launch. The satellite will carry a UHF payload for Italy and an X-band payload paid by the French MoD (€120 million contribution; C$185). France and Italy also cooperate on the Athena Fidus program, for unsecured communications services. The Italian MoD contributes €35 million (C$53m) to the program for a Ka- and EHF payload.

Government Expenditures

Funding strategy

- The civil space budget **strongly increased** at the end of the 1990s in relation with national activities, especially linked to the International Space Station as part of a bilateral agreement with NASA. Italian space budget **experienced growth** of 6% over the past five years, reaching €804 million (C$1.1 billion) in 2011. Of this amount, €699 million (C$930.5 million) (87%) were allocated to civil activities and €106 million (C$141 million) (13%) to defense.
- In recent years, funding for national activities grew the most significantly mainly **due to increased expenses** for operational centers (in relation with the l'Aquila disaster in 2009) to reach 41% of overall civil related spending in 2011. In comparison, funding to ESA programs **remains constant** still representing the majority of Italy's civil space funding. Italy is the third contributor to ESA.

Funding trends by programs

- The budget for defense space systems **follows procurement** cycles of the national SatCom and EO systems: it peaked in 2007/2008 in relation with the development of Sicral 1b and COSMO-SkyMed. Since 2010, funding is driven by the development of SICRAL 2 and Athena Fidus (€106 million (C$141 million) in 2011).
- For the next 10 years, the "Strategic Vision" anticipates a constant annual funding of €600 million (C$798 million) from the Ministry of Education, Universities and Research and total resources for ASI of €7.2 billion (C$9.5 billion) (including funds from the MoD and residual budgets) over 2010-2020. That means a **decrease** of the civil budget, that could be compensated by other resources if Public Private Partnerships for national programs can be arranged.
- Defense funding should rise until the launch of Sicral 2 in 2013, possibly reaching €130 million (C$173 million). It would then decrease, almost entirely **devoted** to the MoD contribution to COSMO/SkyMed Second Generation.

Key investment areas

•Earth observation is the **first domain** of investment of the Italian national civil space program, representing 20% of the funding in 2011. The budget has entered into a decreasing cycle with the end development of COSMO-SkyMed First Generation. On the opposite, contributions to ESA programs have **increased** over the past three years, mainly for GMES in which Italy contributes 30%. Earth observation is **expected to remain** the first area of spending over the next decade, accounting for half of funding for national activities and 28% of Italian contributions to ESA programs, according to the strategic plan.

•**Science and exploration** is the second field of investment of the national program, with 23% of total civil funding. Growing contributions to ESA programs brought the share of science to more than 20% in the past three years and is **now balanced** with national spending. Over the next ten years, science and robotic exploration is anticipated to represent 25% of the Italian budget for both national and ESA programs.

•Funding for satellite communications increased significantly reaching €69 million (C$91.85 million) in 2011 split evenly between national and ESA activities. SatCom now represents 12% of the national investment for civil activities. Over the next decade, telecommunications are expected to represent 11% of the civil budget for national activities and 6% of the budget for ESA programs.

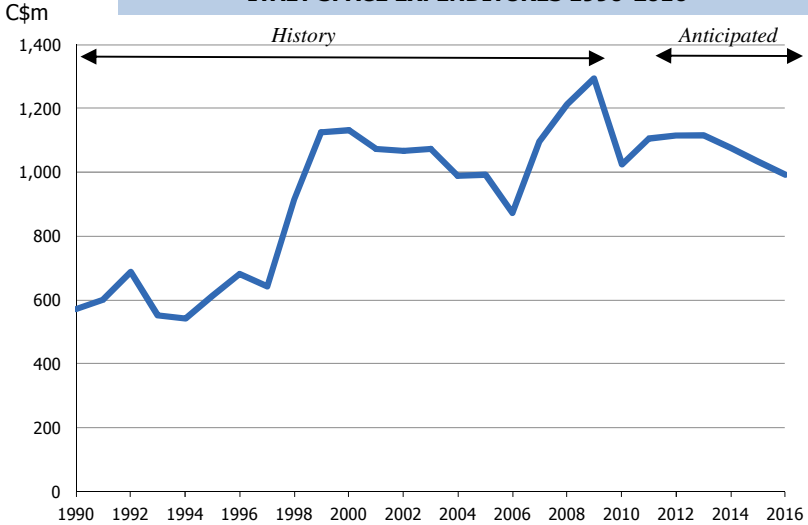
•Launch vehicle funding is **essentially devoted** to ESA . At national level, the launcher budget has fluctuated around €10 million (C$15 million) over the past four years for R&D on VEGA. Launch vehicles should represent 27% of the Italian contribution to ESA over the next 10 years.

•Human spaceflight represented 3% of the national budget in 2011 and 15% of the Italian contributions to ESA. Funding to ESA is decreasing, as development programs have been completed. The share of human spaceflight should represent less than 10% of funding in the coming decade.

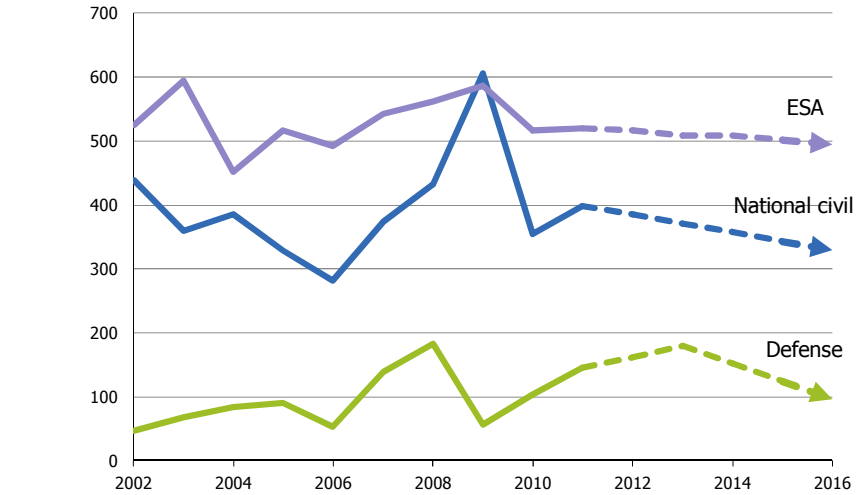
•The Italian technology program has been entirely conducted on the national budget over the past three years, accounting for 3% of the funding for national activities in 2011. Technology should **remain a limited domain** of investment even though increasing since the strategic plan identifies to raise investment to ESA's technology program at 5% of Italian contributions.

Italy
Government Expenditures

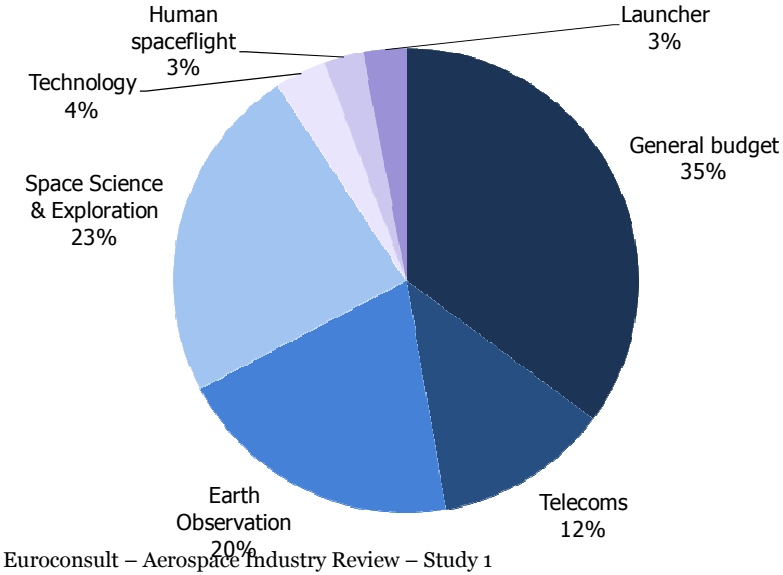
ITALY SPACE EXPENDITURES 1990-2016



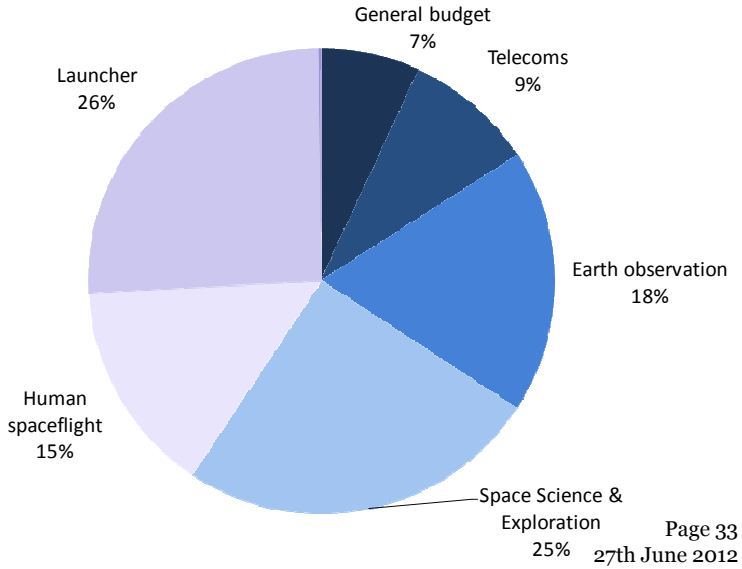
SPACE EXPENDITURES BY PROGRAMMES : 2002-2016



ASI 2011 BUDGET : TOTAL: C$0.4 BILLION



ESA 2011 CONTRIBUTION: TOTAL: C$0.5 BILLION



Italy
Industry policy

Profile of the national space industry

- The Italian space industry is the **3rd largest space industry in Europe**, centered around the Lazio region, just behind France and Germany and is relatively young (50% of enterprises begun in the 90s).
- Revenues were estimated to total nearly €1 billion (C$1.3b) in 2010, thought to be roughly equally split between upstream and downstream sectors.
- The Italian space industrial scene is dominated by **Thales Alenia** Space and its counterpart for the ground segment, **Telespazio**, both owned by Thales and Finmeccanica. It is estimated that both actors hold 50 to 60% of Italian space jobs. Two other large players on the Italian space scene are Avio and Galileo Avionica, part of Selex Galileo, itself a Finmeccanica company.
- Medium size space industrial actors include several ground software & services providers (Elsag-Datamat, Vitrociset, Space Software Italia), and a small satellite system integrator (Carlo Gavazzi) which belongs to OHB.
- A number of smaller space actors can also be found, providing space hardware (Alta, for electrical thrusters, Caen for space electronics and Asics, Microtecnica, a supplier of fluidic equipment for Vulcain, Rheinmetall Italy, a supplier of space structures, microwave electronics and ground support equipment), or software (ex Intecs Sistemi).

Industry policy

- Since 2009, the Italian space policy has been supporting small and medium-sized enterprises who play a significant role in the Italian industrial landscape. In recent years, the Italian industry benefited mainly from the growth of the government market, responsible for a 7% CAGR in revenues over 2005-2010. Nearly **80% of revenues are generated from institutional programmes** (of which 38% comes from ESA), with the remaining 22% coming from the commercial market.
- ASI prioritised a high level of involvement of SME's in the Cosmo SkyMed projects; the contract to the system's prime manufacturer required a **minimum involvement for SME's** of 25% of the overall qualified work. The Sicral program benefited from financial support of the Ministry of Economic Development, as part of its industry competitiveness and high technology initiatives.
- One initiative is that ASI is engaged in a cooperation agreement (2010-2013) with the national Space Industry Associations for promoting an effective industrial policy for the development and growth of Italian SMEs.

Italy space industry: key data

	Main companies	Revenues	Jobs
Satellite systems and equipments	Thales Alenia Space , Galileo Avionica, Carlo Gavazzi	~C$308 million	1100-1300
Launchers	Avio	~C$411 million	900-1000
Ground systems and services	Telespazio, Elsag-Datamat, Vitrociset, Space Software Italia	~C$616 million	800-900

Sources: Space News, Sidereus

Challenges

•The Italian space industry is to a large extent controlled by the Finmeccanica conglomerate and appears **predominantly dependent on institutional programs**. This could cause some risk in the context of economic turmoil which Italy is currently subject to.

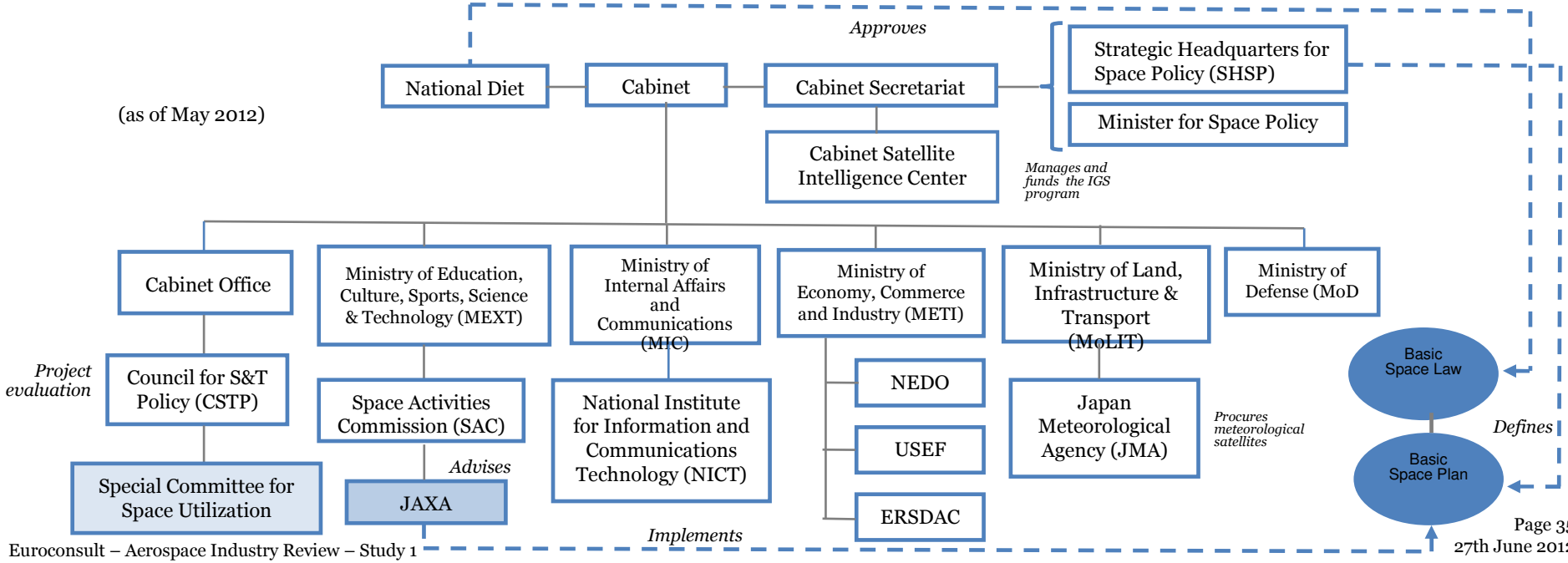
•Politico-economic uncertainties are in fact subjecting the space policy objectives to **challenging times**, imposing increasing reliance on private-sector involvement notably through PPPs.

•Participation in the development of commercial satellites seems limited and so are direct exports of equipment. However, for many of the Italian space actors (excepting TAS and Carlo Gavazzi), space is only a small fraction of their revenues, which should make them resilient to governmental space funding ups and downs.

Japan
Governance of the national space program

Outlook of key government stakeholders and decision making

- The Japanese Space Exploration Agency (JAXA) was created in 2003 by the merger of NASDA (the former space agency), ISAS (the Institute for Space and Astronautical Science), and NAL (the National Aerospace Laboratory). This consolidation was seen as a means of **improving the efficiency of the space program** and save money. JAXA is in charge of aerospace programs, from basic research to development and utilization. It benefits from advice from the Space Activities Commission, which is part of its supervising authority, the MEXT.
- Since 2008, the Japanese space policy is defined at the **highest government level**, with the Strategic Headquarters for Space Policy (SHSP) **under the Cabinet Secretariat** which also coordinates the activities of the different ministries involved in space. It consists of all ministers with an interest in space and is chaired by the Prime Minister. Space development is managed by a minister also attached to the Cabinet Secretariat.
- Ten ministries (including the Prime Minister's Cabinet) contribute to space funding. This compartmentalized structure compromises efficiency and **further consolidation is sought**.
- A reform proposal, drawn up by the SHSP, was officially approved by the government in February 2012. The reform plans a **greater involvement of the Cabinet**, already in charge of the Intelligence Gathering Satellite (IGS) program, in space activities. A « Space Policy Commission » will be created within the Cabinet Office, made of experts who will discuss the national space policy and make recommendations to the government. It will also evaluate space spending. Consequently, the Space Activities Commission (SAC) of MEXT will be cancelled. The new Commission will have a broader role than SAC, covering the entire Japanese space program instead of MEXT activities only.
- **JAXA will be able to work on defense projects**, in accordance with the Space Law enacted in 2008.



National Space Strategy

- Historically, Japanese Law established that the Japanese space program would be limited to "promotion of the development and use of space exclusively for peace (i.e. "non-military") purposes. A new policy framework was defined in 2008 by the Basic Space Law (BSL), followed in June 2009 by the Basic Space Plan (BSP).
- The BSL is **Japan's first national space law**. It aims to regulate and promote space activities in both public and private sectors and has three primary objectives:
    1. Promote industrialization and commercialization of Japan's space activities;
    2. Relax the interpretation of « peaceful use » of outer space from « non-military » to « non-aggressive » in order to use space for defense purposes.
    3. Streamline Japan's space organizations.

- The BSP was decided as **the first national comprehensive strategy** by the SHSP, in accordance with the Space Law. A Special Committee for Space Policy, whose members were opinion leaders from various fields, was established to make recommendations on the plan. Five actions are put forward:
    1. Shift from the development to utilization of space in accordance with social needs; applications take precedence over technology.
    2. Increased support to the space industry.
    3. Systematic use of the "space" tool in diplomatic relations, especially in Asia. This region is given a special status for strategic cooperation.
    4. Implementation of a defense program.
    5. Promotion of Japan's specific technologies. The focus is placed on commercialization.

- **National security is a main aspect** of the Basic Space Plan, which outlines the country's first-ever space-based defense initiatives in reaction to North Korea's launch of a long-range rocket in April 2009. Japan intends to contribute to global and regional security.
- Prior to the BSP (in January 2009), the Ministry of Defense (MOD) issued its "First Guideline", the first comprehensive policy paper concerning its position for utilizing space. It includes the following objectives:
    1. Intelligence gathering for exclusively terrestrial defense.
    2. Intelligence gathering and communication for meeting diverse threats and developing a new security environment.
    3. Continuous observation and surveillance for rapid response.
    4. Information sharing and communication for strengthening the Japan-US alliance.
    5. Intelligence gathering and communication for improving performance of peacekeeping operations.
- Based on these priorities, the current **National Defense Programs Guidelines** (NDPG), covering the period 2010-2015, promotes the development and use of outer space with a view to strengthening information gathering and communications functions. The MOD hosts a space bureau (created in July 2008) and a Space Development and Use Promotion Committee.

Space policy and strategy outline

Civil programs are diversified, comprising a launch vehicle family and a series of Earth observation, communications and scientific satellites. Japan also brought an important contribution to the International Space Station. More recently, navigation has become a new focus. Priorities are being redefined, to fit in a tight budget and adapt to the difficult environment created by the economic crisis and the earthquake and tsunami disaster of March 2011.

•**Navigation**: the highest priority in the near future, as a key element of Japan's export policy to Asian countries for the commercialization of services.

•Science & Exploration: Japan has a large scientific community in the national astronomical observatory and universities, with key capabilities in astronomy, planetary exploration and robotics. The scientific program would be favored, with missions of the type of Hayabusa (asteroid lander), which benefited from strong public support. Exploration ranks high in long-term priorities. A moon exploration strategy was released in July 2010 by the SHSP, focused on robotics.

•**Earth observation**: contribution to global environmental issues and, by extension, disaster management, is a main focus of the Japanese space policy. Japan aims at creating a system for disaster management combining EO satellites, communications satellites and data relay. But some EO missions could be delayed due to other priorities (navigation, science).

• **Human spaceflight**: likely affected by new priorities, as this activity does not generate real benefit in terms of industrial competitiveness. Although studies are being pursued on key manned flight technologies, the government has not taken a firm position on independent Japanese capabilities. A decision for a manned space program is expected around 2015.

•**Launcher**: Japan operates two launch vehicles with GTO capabilities (H-IIA and B) and develops a smaller rocket to launch domestic EO and scientific satellites, and maintain competencies in solid propulsion. Priority is given to reliability and commercialization. First commercial launch took place in May 2012, with Kompsat-3.

•**Technology**: technology is rapidly validated in orbit with small satellites in order to minimize risks and develop cooperation between Japanese space institutes. A main area of interest is Space Solar Power, in which Japan has become a leading country.

•**Satcom**: Japan has been active in supporting R&D for advanced communication technologies (data relay, optical inter-orbit communications and ultra-high data rate communications) until launch of WINDS, in 2008. Since, JAXA scaled back its efforts. R&D is especially conducted on a Satellite/Terrestrial Integrated Mobile Communications System (STICS) to secure communications in case of disaster.

Dual use and defense programs

- The Intelligence Gathering Satellites (IGS) program was initiated in 1998 in response to North Korea's launch of a ballistic missile over Japanese territory. It primarily serves national defense, but satellites are increasingly used for peacekeeping and disaster relief operations.
- **Dedicated Satcom Capacity is envisaged in PFI** (Private Finance Initiative). To prepare this initiative, the PFI Law was revised in May 2011 to add satellites to the items of public infrastructure that can be financed by private capital.
- As part of Japan's willingness to increase the role of satellites in national security, the MoD is considering the development of an **early warning capability** that would give the country a degree of independence and complement the US system. Potential development of a satellite, of American design, would be conducted within the framework of the joint US-Japan security agreement. It would also be used for the prevention of natural disasters.

Government Expenditures

Funding strategy

- **Japan's space budget is allotted through nine ministries plus the Prime Minister's Cabinet Office**, which manages the national security IGS satellite program. The largest portion goes to the science and technology ministry (MEXT), JAXA's supervisory ministry.
- Space investment increased sharply until the year 2000, when it peaked at 329 billion yen (C$3 billion), to fund an ambitious space program focused at developing independently satellite and launch vehicle technologies.
- **The budget was then reduced after a series of technical difficulties** that plagued the national space program. Although the decline of MEXT funding was halted in 2004 after creation of JAXA, space funding from other ministries continued to decrease until 2007.
- These **"other ministries" are now responsible for the growing trend of the Japanese space budget since 2008**. In 2011, the budget amounted to 286 billion yen (C$3.5 billion), split between civil (69%) and defense/security (31%).

Funding trends by programs

•Japanese civil space expenditures of 198 billion yen (C$2.1 billion) in 2011 are split between MEXT (for JAXA) and other ministries, with shares of respectively 85% and 25%.

•The economic crisis reduced MEXT funding to 169 billion yen (C$2 billion) in 2011. Due to reconstruction costs, slow recovery is not expected before 2013, in line with inflation.

•After a 26% drop of funding in 2010, the other ministries (except Cabinet Office and defense) increased their space investment to 29 billion yen in 2011 (C$355.6 million). This trend is expected to be maintained in the next few years to cover development of two geostationary meteorological satellites to be launched by 2016.

•Defense and security applications started in 2000 with the development of IGS, funded by the Cabinet Office. Until 2010, funding was maintained at around 60-70 billion yen (C$ 735.81-858.44 million) per year, including purchase of commercial communications services. In 2011, the budget jumped to 88 billion yen (C$1.07 billion) to fund R&D on X-band transponders for future SatCom spacecraft. It is expected that the space defense budget will grow moderately, but no major development on public funds should be undertaken before the publication of the next five-year Defense Program Guideline in 2016.

Key investment areas

•Earth observation is the first area of total spending in 2011, thanks to the IGS defense/security program (76% of the total EO expenditures). Seven additional satellites are expected to be launched by 2017, for roughly 370 billion yen (about C $4.53 billion). Civil Earth observation is now oriented toward smaller missions, less costly than the two ADEOS launched in 1996 and 2002.

•Human spaceflight is the first area of civil spending, for the operation of the Japanese Experiment Module (JEM) and the HTV cargo transportation vehicle. But space infrastructure is now strategically less important.

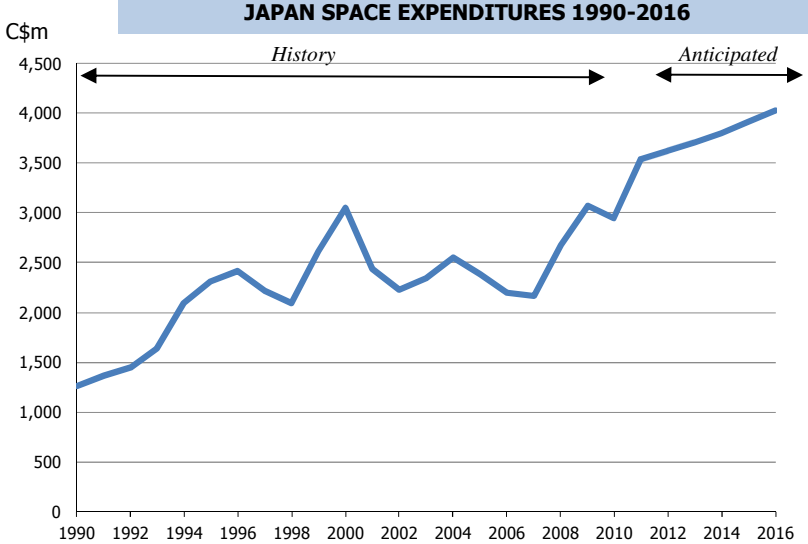
•Funding for launcher development has decreased over the past two years, after first flight of the H-IIB in 2009. Although H-IIA operations were transferred in 2007 to MHI, JAXA continues to fund improvements and modifications and also develops a smaller rocket, Epsilon. **Cost reduction is targeted**.

•JAXA's SatCom expenditures decreased sharply after launch of WINDS, in 2008. R&D is now mainly conducted by the NICT, with a budget of C$40 million in 2011. Most of the expenses are targeted to defense, for lease of commercial capacity and R&D on transponder design, since 2011.

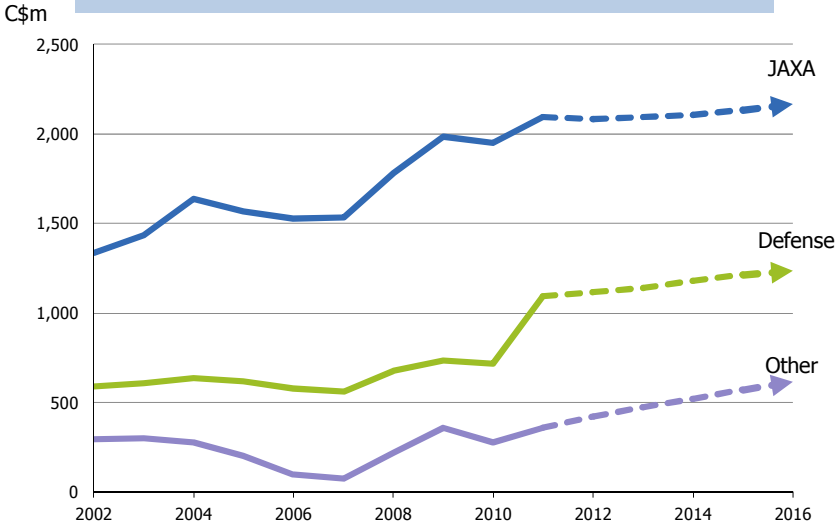
•Space science expenditure has decreased over the past five years, after launch of Selene-1 in 2007. Four scientific missions have been announced by 2018, focused on astronomy and planetary science. Japan expects to validate technologies with a moon landing around 2017, in order to contribute to future international exploration projects. However, this program faces funding difficulties and its development is uncertain.

Japan
Government Expenditures

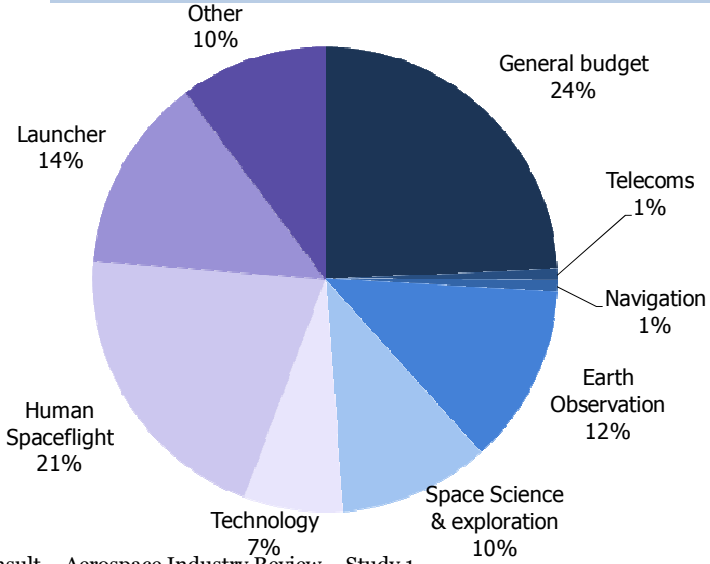
JAPAN SPACE EXPENDITURES 1990-2016



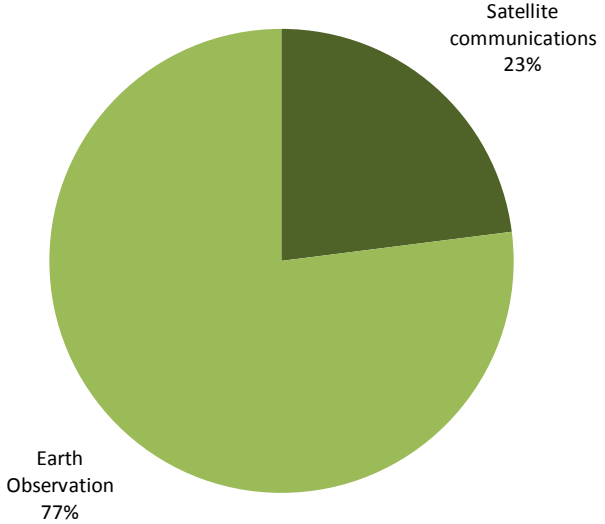
SPACE EXPENDITURES BY PROGRAMMES : 2002-2016



JAXA 2011 BUDGET : TOTAL: C$2.1 BILLION



DEFENSE 2011 BUDGET: TOTAL: C$ 1 BILLION



Industry policy

Profile of the national space industry

- Revenues of the Japanese space industry were estimated at $2.7 billion (C$2.8 billion) in 2010 by SJAC (the aerospace industry association) distributed between space vehicles (satellites and launchers: 84%), ground facilities:11%, and software (5%). Revenues slumped in 2003 due to the fall of national government and export markets. Space segment sales have been recovering since 2006, while ground segment sales have stabilized. Exports accounted for 6% of the total space sales in 2008.
- The space industry employed 6,250 persons at the end of 2009, down from more than 10,000 in the middle of the 1990s.
- The main companies are IHI and MHI (for launch vehicles, propulsion, ISS infrastructure); NEC and Mitsubishi Electric (MELCO), for satellite systems and space equipment. MELCO commercializes the DS2000 platform for communications satellites.
- Space is marginal in the turnover of these large groups (less than 1% for MELCO and MHI), and has not been a priority for them.
- The Society of Japanese Aerospace Companies (SJAC) is the sole organization representing the interests of the aerospace industry.

Industry policy

- Japanese companies acquired space capabilities through partnerships with US companies and the ETS (Engineering Test Satellite) program of the space agency (NASDA/JAXA)
- In 2007, operations of the H-II launch vehicle were transferred to MHI.
- Promotion of industrialization and support to space industry have emerged as a new priority of the Basic Space Law and Basic Space Plan.
- The government wants to increase cooperation with the private space sector by several means:
  - Technology transfer by JAXA
  - Loans and Official Development Assistance (ODA) to stimulate sales to other Asian countries (provision of two radar satellites by NEC to Vietnam in 2011)
  - A reform of the JAXA Law is ongoing, to allow space companies to conduct some R&D activities previously reserved to the agency
  - Missions abroad (especially in Asia), to promote Japanese space products.

Japanese space industry: key data

	Companies	Revenues (2010)	Jobs (2009)
Satellite systems and equipments	MELCO; NEC; USEF	$2,395 million (C$2.5 billion)	6,250
Launchers	MHI; IHI		
Ground systems and services	Hitachi; Fujitsu; MELCO; NEC	$307 million* (C$ 322.5 million)	

* Ground facilities only

Source: SJAC

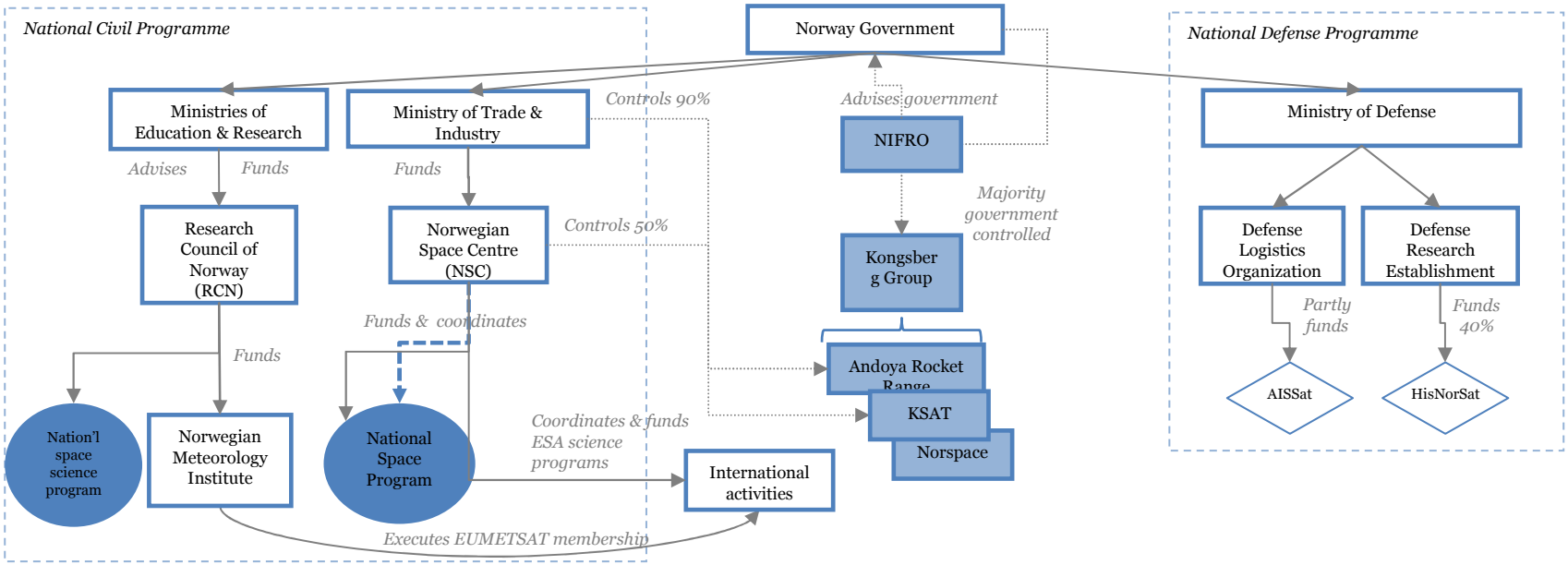
Challenges

- The parity yen/$ may hamper the competitiveness of MELCO and NEC, both as satellite systems and subsystems exporters.
- Weakness of the domestic market: the Japanese satellite operators have just renewed their fleets and there are few JAXA projects, not yet financed.
- The private industry has so far be reluctant to finance space projects (the PPP planned for the QZSS navigation system failed).
- Financing of the QZSS is a key issue, as the system is intended to boost exports in the Asia-Pacific region and favor the development of Japanese space companies through the offer of new products and services.

Governance of the national space program

Outlook of key government stakeholders and decision making

- Norway set up a **national agency (Norwegian Space Centre -NSC)** fully dedicated to space activities in 1987, when it became an ESA Member State.
  - NSC was first established as an **independent body** rather than a Government agency with the objective to increase programme management efficiency. From the beginning, it was given a wide responsibility to coordinate the national space effort, which it funds, and to focus on ESA activities.
  - In 2004, **NSC became a public administrative** body under the responsibility of the Ministry of Trade and Industry (NHD). This change was caused by new Norwegian legislation regulating foundations which had minor effects on the NSC. The choice of NHD for administrative supervision reflects the Norwegian government's will to make the NSC an **instrument for industry policy**.
- NSC not only **implements but also defines the national space policy.** Its responsibilities include the compilation of the National Long-Term Plan for Space Activities, which relies on input from ministries, industry, research entities and other stakeholders of the space sector.
  - Public and private actors jointly revise the plan regularly; in fact the government controls several commercially-run entities linked to the **Kongsberg Group**, the largest industrial space player in Norway.
  - The Norwegian Industrial Forum for Space Activities (NIFRO), founded in 1986, represents the space industry and acts as an advisor to the Parliament
- The **Ministry of Defence** issues the Long Term Defence Plan and controls structures such as: the Norwegian **Defence Logistics Organisation** (NDLO) - responsible for managing communication technology activities, and the **Defence Research Establishment** (FFI) for the Armed Forces. FFI keeps tracks of science & technology advances affecting security issues and plays a key role in defense R&D (e.g developing algorithms for space-based surveillance for the Navy).



Space policy and strategy outline

National Space Strategy

- Norway's space strategy is essentially turned towards **international cooperation**; national activities focus on developing specific capabilities often related to its geographical proximity with the Arctic. The main **objectives** of the NSC's National Long-Term Plan for Space Activities, regularly updated, are to:
    - Create **10% annual growth** in the space sector, through developing national industry and services
    - Meet **national user needs**, both civil and military
    - Attain a leading **international position in space research**
    - Maintain a leading role in space-related **ground infrastructure**, notably with the Andøya Rocket Range and KSAT ground stations on which many European LEO EO operators rely on.
- NSC funds civil activities under a **National Support Scheme,** which was driven by NHD & approved in 2008 by the European Free Trade Association, to ensure the development and strengthening of the Norwegian space industry and the development of nationally vital space services.
- The development of equipment and services related to satellite communications, satellite navigation and Earth Observation constitute the highest priorities; **space technology R&D** has been playing an important role since the 1960s to achieve this both at national level, with activities co-funded by industry, and particularly through ESA.

ESA and international programs

Norwegian space activities heavily rely on international cooperation and have widely benefitted from bilateral arrangements, notably with Canada (use of Radarsat over the Arctic), NASA (sounding rocket developments) and Japan (atmospheric research).

- ESA has been a cornerstone for international programs, through which Norway **develops key technologies** notably in the satcom field, which helps supports its industry base.
    - This investment, through **GSTP** - generic supporting technology program to which Norway is one of the leading participants- and **ARTES**, allows Norway to support its national industry.
- Although not an EU member, Norway signed a **bilateral cooperation agreement with the EU** for participation in the **Galileo** program, enabling it to fully benefit from related contracts. KSAT also cooperates with partners in Asia and Africa to enhance its ground station network with mid-latitude stations.

Norway domestic program

The main priorities over the past decade and as of today are predominantly the development of the Automated Identification System **(AIS)** mini communication satellites (AISSat) and ongoing ground segment leadership regarding its **satellite-receiving stations** and high-latitude **launcher developments**.

- Owing to its proximity to maritime channels, Norway has developed a niche market strategy related to **maritime tracking** using **AIS**. The development of the AISSat systems has become a flagship national program vital for the Norwegian Coastal Administration, undertaking civil ssecurity operations.
- Linked to this, **Search & Rescue applications** are taking a prominent position due to promising business opportunities brought about by Galileo equipment provision. Norway joined the Galileo program in 2010, committing funds through the EU & securing Galileo ground station contracts.
- **Space science research**, focusing on **solar physics** & **aurora** studies, is driven by Norway's unique geographical location. Norway also leverages on bilateral agreements on scientific data use, notably participating with Japan (downloading Solar-B data) & India (undertaking a Chandrayaan-1 experiment).
- The related use of **sounding rockets** for scientific research through its launch infrastructure (Andoya rocket range) constitutes a parallel interest.

Defense programs

•Norway's defense strategy has largely been aligned with **international** NATO-led peace-keeping **operations** although increasing activity in the **Arctic** is warranting additional interest for securing sovereign areas.

- •The **2008 High North Strategy** includes civil and military security as a key tenet for ensuring nuclear safety & emergency preparedness as well as supporting decision-making through surveillance & intelligence by the Armed Forces.
- •The Norwegian government presented its **long term defence plan** in March **2012**, yet to be approved by Parliament, however no specific focus on space matters appear to be raised; cost-effectiveness & emergency preparedness feature as key items.

•Norway's involvement in foreign conflicts has prompted the defense Forces to propose the procurement of a dedicated secure satellite to serve its **growing broadband communication needs**.

- •The satellite, **HisNorSat** , will be jointly acquired and operated with the Spanish Defense Forces following years of bilateral cooperation between the 2 countries (Spain's Navantia shipbuilder has delivered 5 frigate warships to the Norwegian Navy over 10 years).
- •The aim is to provide **better strategic communications coverage** for the two countries, in the military as well as civilian sectors, but in particular to improve communications of Norwegian forces serving abroad or at sea (Afghanistan, Chad and other countries).
- •The ambitious agreement is the first visible result of **Norway's new policy to engage with NATO partners** on major system contracts. It will represent the first Scandinavian nation to acquire its own Milsatcom capacity.
- •The two countries signed a memorandum of understanding (**MoU**) on the project in **2010** and will implement a joint venture (JV) which Norway sees as a l**ow cost and low risk option**. It also brings operational advantages to working with a country with long experience in SATCOM planning, acquisition and operation (through Spainsat).
- •An outsourced **service-type agreement** could be implemented by a **Spanish/Norwegian JV** following an anticipated **launch in 2015**.

Norway
Government Expenditures

Funding strategy

- Following the creation of the Norwegian Space Centre, the Norwegian space budget averaged a **steady NOK220 million/year** (C$41.8 million) under the Council for Scientific and Industrial Research until its transfer to the Ministry of Trade & Industry in 2004.
- The total space budget is estimated to have increased strongly to NOK661 million (C$117 million) in 2011, **predominantly driven by** increasing **ESA** investments (+127%) and the start of defense space-related expenditure, averaging NOK80m/yr from 2008,
- Future spending is expected to be dramatically increased, due to HisNorSat funding, peaking in 2015 to NOK1.4billion (C$260m) before retracting.

Funding trends by programmes

•Norwegian **contributions** to **ESA** represented NOK495 million (C$87 million) in 2011, increasing by 14% CAGR during the last five years and accounting for **85% of overall civil investments** in space. Norway is pursuing a diversified strategy towards ESA programs across most areas, led by telecoms (26%), technology (20%), science & exploration (17%) and EO (15%).

•**Defense** spending recently **overtook civil** expenditures, due to the increasing needs linked to Norway's Forces involvement in NATO. To reduce commercial satellite capacity leasing costs, Norway has subsequently been planning the **development of the 1st national communication satellite**. As a result, space defense is set to constitute the **1st area of investment over the coming years** once the procurement contract is placed (expected in 2012); Norway's share in the project will amount to C$156.2 million, excluding additional overheads on the operating side.

•The **national civil** space program, funded by NSC, has generally only amounted to around **10% of Norway's total space budget**. It focuses on space science & EO.

•Other **European –level** investments include: Eumetsat, spending towards which has remained stable, averaging NOK38 million (C$6.8 million) between 1999-2011, and contributions to the Galileo project (NOK151 million, C$25.9 million).

Key investment areas

•Earth observation has been Norway's primary area of investment accounting for 25% of funding towards ESA programmes, marked by increasing funding to support **EOEP** and **GMES** programmes. At national level, NSC helps develop the service industry through the **SatHav** (use of radar), **SatRisk** (subsidence monitoring) & **SatLuft (air pollution) programs.** Norway is also a world leader for the retrieval of satellite data from polar-orbiting satellites through KSAT.

•**Satcom** activities primarily focus on supporting the national ground equipment sector through ARTES programs (especially -3, 4 & 5 and recently ARTES-20).

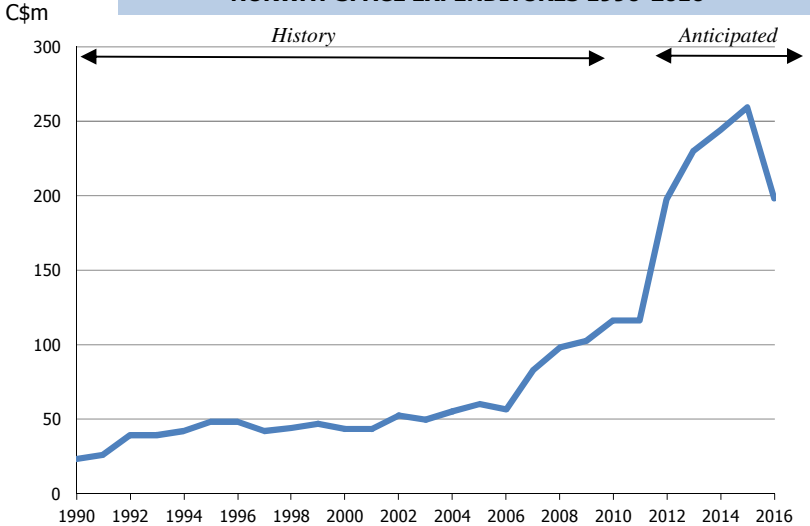
Technology programs now represent the 2nd area of Norwegian funding for space, after being almost inexistent 5 years ago. Norway directs its contribution towards the **GSTP** programme, as it has strong capability through Norspace regarding on-board electronic products for satellites.

•**Science** programs have received regular increases in funding over the years as well; a primary focus is on the ESA **Herschel Plank mission**

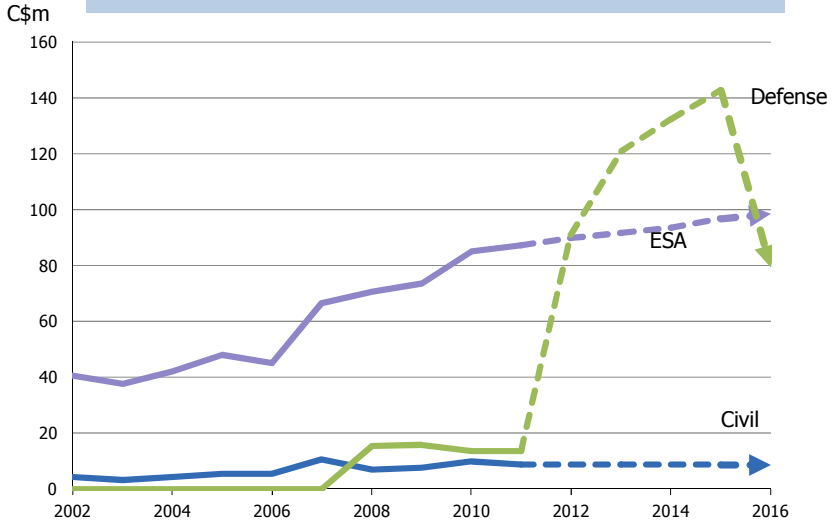
•Launcher facilities of the Andøya Rocket Range constitute a key national activity towards which additional funding (undisclosed amount) was approved in 2010 to upgrade the facilities dating back from 1962 and 1997.

Norway
Government Expenditures

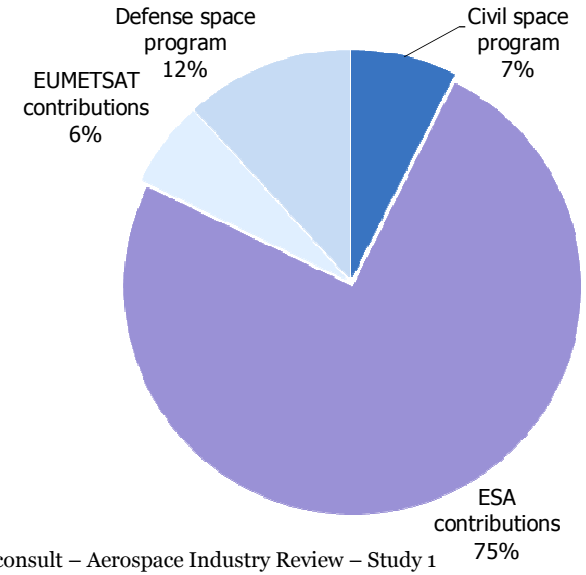
NORWAY SPACE EXPENDITURES 1990-2016



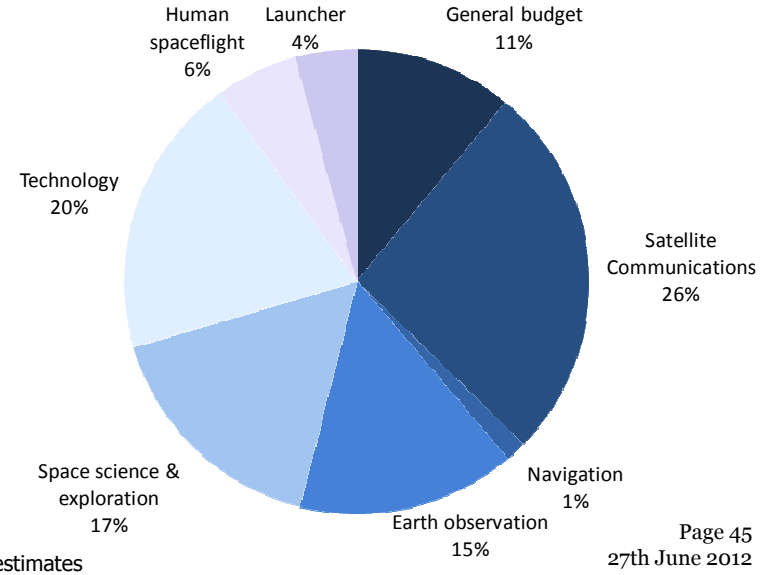
SPACE EXPENDITURES BY PROGRAMMES : 2002-2016



NORWAY 2011 TOTAL BUDGET : Total : C$117 MILLION



ESA 2011 CONTRIBUTION: TOTAL: C$87 MILLION



Primary data: NSC, ESA & Euroconsult estimates

Norway
Industry policy

Profile of the national space industry

- The Norwegian space industry is backed by **strong industrial groups** and has made good use of its unique geographical position in the Arctic region.
- Norwegian space actors are for the most part **subsidiaries** or divisions **of medium-size industrial groups** active in sectors such as Defense, Maritime, Oil & Gas. NIFRO accounts for 29 research entities or companies as members.
- Most are government-affiliated to a certain extent and rely on other sector revenues in addition to their space activities.
    - •The most prominent group is **Kongsberg**, owned 50% by the government, whose Defense & Aerospace company (KDA) controls 50% of its Satellite Services (KSAT) subsidiary (NSC owns the rest).
    - •The main commercial activity relates to **satcom** broadcasting equipment and **services** (Vizada, Telenor, Norspace, STM)
- The government-backed and diversified nature of companies, as well as the recent consolidation within the Kongsberg Group indicate a relatively **healthy industry**.
- Total space turnover was NOK5.7 billion (C $1 billion) in 2010, of which 68% was exported and around 80% is services-related.

Industry policy

•Norway has been successfully pursuing several **niche markets** in the space sector (satcom applications for merchant fleet, AIS for vessel identification…).
•The **National Support Scheme** has been instrumental in being able to fully benefit from the country's **highly leveraged stake in ESA**. It has resulted in the critical involvement of a number of SMEs and larger entities that provide services directly to ESA programs:

- Namo Raufoss supplies mechanisms to the Ariane & Vega rockets
- DNV provides quality assurance support services to ESA
- OSI Optoelectronics manufactures custom-made photosensors and multi-chip modules hybrids for ESA

- Subscription to ARTES program in particular have contributed to **satcom** services & equipment providers generating **70%** of national space sector **revenues**.

Norway space industry: key data

	Companies	Revenues (2010)	Jobs
Satellite systems and equipments	Kongsberg, OSI…	C$199.6 million	120-130
Launchers	Kongsberg	n.a.	40-45
Ground systems and services	Vizada, Norspace…	C$808.9 million	130-140

Source: Euroconsult estimates and based on NIFRI & OECD information

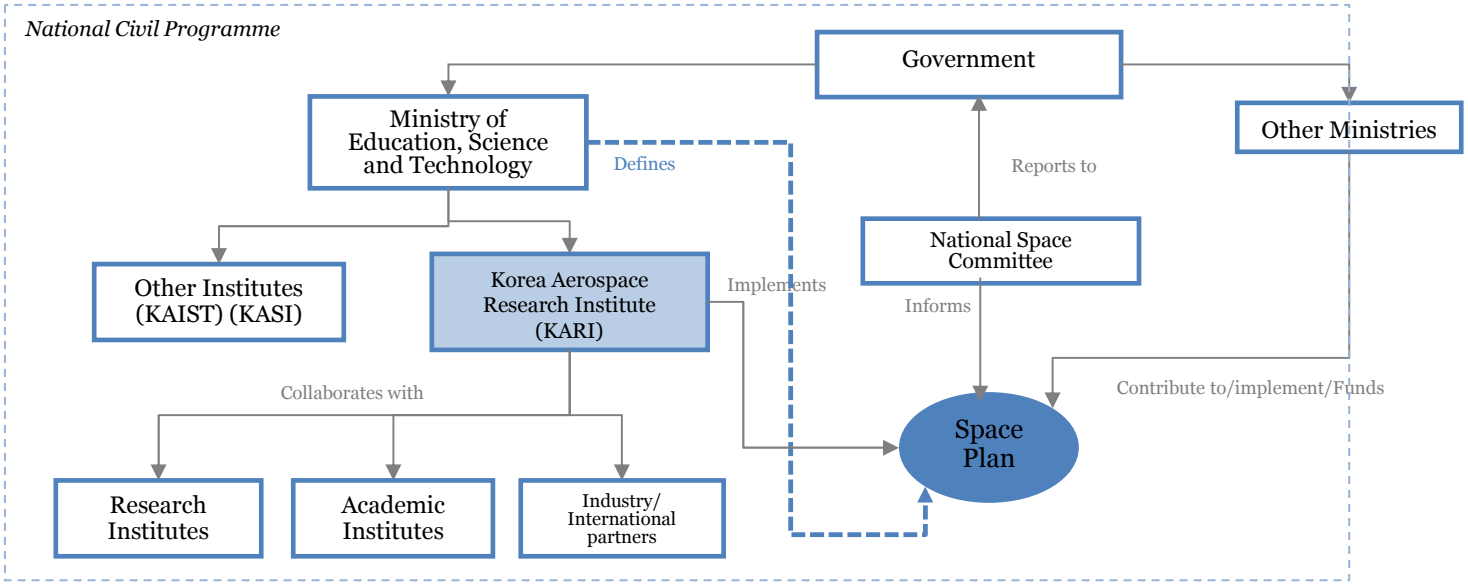
Challenges

•Industry developments slowed down around 2005, mainly linked to the acquisition by foreign competitors of a number of Norwegian space players (e.g. Nera Satcom, Tandberg Television). This highlighted the financial attractiveness of some Norwegian space actors and the **challenge of keeping successful** national **companies** in Norway.
•Thanks to its oil and gas strongly driven economy, Norway has not witnessed the turmoil of the economic **crisis affecting its European neighbors**. However, its **heavy leverage into ESA** programs could lie at the mercy of other contributing members not being able to keep up funding levels which Norway has come to rely on to develop its national industry.
•Decision of the future European launcher, GMES financing and future EUMETSAT programs could have direct impacts on the structure of Norway's space industry.
•Government elections in 2013 **could create uncertainties** with regards to the national **research policy** which has so far benefited space research..

Governance of the national space program

Outlook of key government stakeholders and decision making

- The Korean Aerospace Research Institute (KARI) was established in 1989 as the **key institute** to promote advanced aerospace research activities.
- KARI was originally a subsidiary of the Korea Institute of Machinery and Metals (KIMM). It became an **independent aerospace agency** in 1996 and now reports to the Ministry of Education, Science and Technology (MEST)and also advises the government in policy making.
- The Korean space programme has developed through a number of **space plans** formulated in the 1990s-2000s by the Ministry of Science and Technology (now MEST), the National Scientific and Technical Council and the Ministry of Commerce, Industry and Energy. **MEST is the ministry responsible for space development**.
- Established pursuant to the Space Development Promotion Act 2005, the **National Space Committee** is the chief policy decision body for the planning and coordination of national space development activities and the long term space strategy. It reports directly to the President and is chaired by MEST.
- Institutes linked to MEST include the Korea Advanced Institute of Science and Technology (KAIST) established to **develop Koreas first satellite** through the Satellite Technology Research Centre (SaTReC) and the Korea Astronomy and Space Science Institute (KASI). Other institutes involved in space activities include Electronics and Telecommunication Research Institute (EIRI), and the Korea Institute of Geoscience and Mineral Resources (KIGAM).
- The Ministry of Defence and the Ministry of Information and Communication are also involved in research and development related to military hardware and satellite communications /digital broadcasting. Other Ministries **support or fund space projects** including the Korea Meteorological Administration, Ministry of Construction and Transportation (MOCT), Ministry of Commerce, Industry, and Trade (MOCIE) and Ministry of Maritime Affairs and Fisheries.



Space policy and strategy outline

Outline of the space policy

- South Korea aims to be **recognized as a 'space power'** at regional and worldwide levels and its space program reflects that ambition. The program has been defined by the 'National Space Development Plan' (1996) and the 'First Basic Space Development Promotion Plan (2007)' created in line with the Space Development Promotion Act 2005. The Ministry of Education & Science Technology (MEST) is working on the '2nd Basic Space Development Promotion Plan' that will update the plan of 2007.
- The objective of the national plan is to **create autonomous operational capabilities** in areas such as Earth observation and meteorology, as well as to develop **domestic industrial capabilities** for satellites and launch vehicles.
- The country took a **two-steps approach** to reach the goal:
  1) Step-One to 2010:
- **Acquisition** of autonomous operational capacities in the EO system (KOMPSAT series) and multi-purpose geostationary satellite (COMS-1). The technology development strategy consists of 3 stages. First, contracting with foreign companies to develop space systems jointly, then in the next stage Korea is responsible for developing the system with support of a foreign partner and in the final stage Korea will design, develop and integrate space systems independently.
- Key **infrastructure development** to operate a space center with launch facilities and ground segment
- Development of Korea Satellite Launch Vehicle (KSLV-1) through **international cooperation**
- Development of the Korea Astronaut program **promoting** national pride and interest in science and technology
  2) Step-two to 2020:
- **Industrialization** of Korean aerospace technology by entering into global satellite market
- Domestic development of a launch vehicle (KSLV-2) and launch services
- Lunar exploration: plan includes an orbiter to be launched around 2020 and a Lander to be launched around 2025 by KSLV-2.

Strategy international partnerships

- South Korea's began its space program through a **collaborative partnership** with UK based Surrey Satellites Technology Limited (SSTL) with the training of KAIST engineers through a technology transfer agreement to develop microsatellite KITsat 1. SaTReC was established to develop the KITsat program and with the KITsat-3 mission **it demonstrated its technological know how** to design, develop and operate microsatellites. A **spin off** (SaTReC Initiative)was established to commercialize this capability. So far SaTReC Initiative has had commercial contracts and formed technological partnerships with Malaysia (ASTB for Razaksat), Dubai (EIAST for Dubiasat), Turkey (Tubitak for Rasat) and Singapore (CREST/Nanyang Technological Institute for Xsat).
- KOMPsat-1 represented KARI's 1st step in space and was built by TRW (now part of Northrop Grumman Corp). Through this program, 25 technical staff of KARI joined the TRW design team alongside approximately 30 engineers from 7 Korean industrial enterprises to **acquire satellite design technologies.**
- KOMPsat 2 was built by KARI with technical assistance from EADS Astrium in France. In October 2005, the French SPOT Image company signed an exclusive agreement for marketing and distribution of images from KOMPsat- 2 outside South Korea, the United States and the Middle East.
- **Russia** has been a **key partner** of South Korea. In 2000 the South Korean Naro Space Centre was built with technical assistance of experts from the Russian KTB enterprise. In 2004 Russia agreed with South Korea to jointly develop a liquid propellant rocket engine through the KSLV-1 program and in 2006-2008 Roscosmos trained and transported a Korean astronaut on a 10 day mission to the International Space Station.
- Participation in a Global Navigation Satellite System (GNSS) Project, the International Space Station (ISS) and the Global Exploration Strategy illustrate Korea's efforts to participate in international cooperative missions.

Government Expenditures

Funding Strategy

- After a 10 year period of **gradual increase**, with a slight dip in the late 90s caused by the Asian financial crisis, the Korean space budget substantially increased in 2006 to KRW 320 billion (C$361.9 million) due in part to the agreement with the Russians to jointly develop the KSLV-1 South Korean launcher.
- The budget decreased by 6% on average per year over 2006 -2011 due to the end of KSLV-1 and COMS-1 program.
- A **sharp increase** in expenditure is expected due to the start of a new investment cycle, an average of KRW$350 billion (C$309 million) over 2012-2016.

Funding trends by programmes

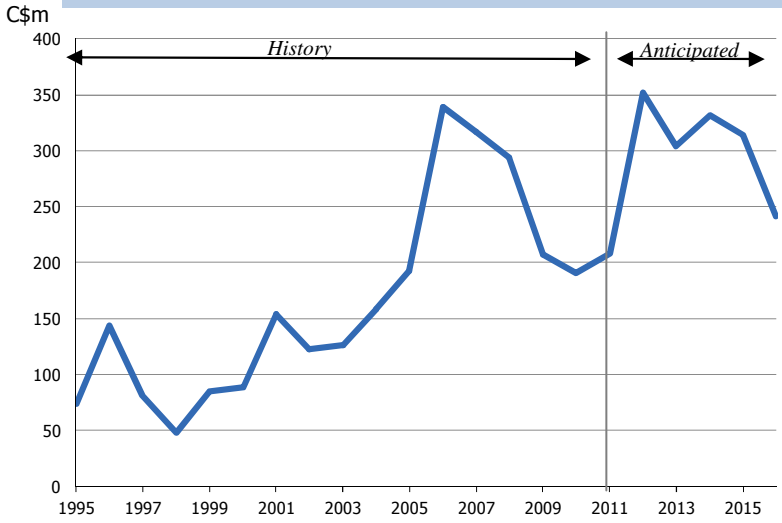
- National space funding is almost **exclusively civil related**; there is little space related defense funding. The Korean Agency of Defence Development (ADD) funded a military payload on the Koreasat-5 launched in 2006. Koreasat-5 was built under a €148 million (C$238 million) contract signed with TAS in 2003 to supply both the multi-mission satellite and its ground control system with the ADD contributing to half the cost of the satellite. The KOMPsat 5 is dual use satellite and at a cost of KRW 101 billion (C$89 million) is funded by KARI.

Key investment areas

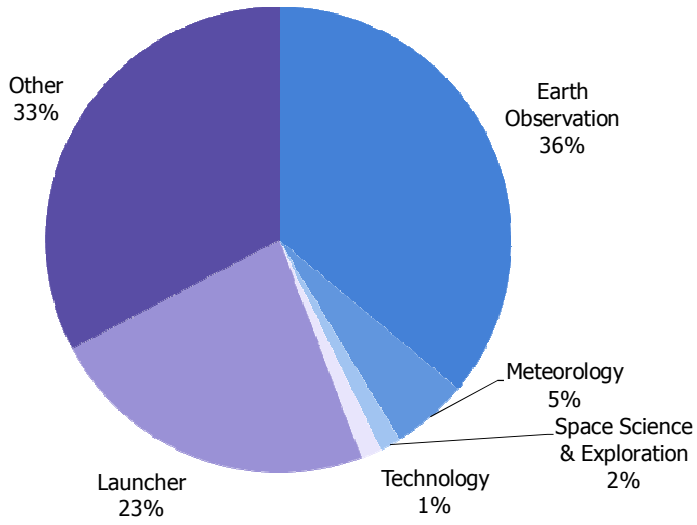
- **Earth observation is a main field of interest** for the Korean Government. The national program in this area focuses on the Korea Multi-Purpose Satellite KOMPsat program. The budget has been stable from 2009 to 2011, making up 36% of the total budget in 2011. It is expected to increase with the launch of KOMPsat 3 & 5 in 2012 and then decrease gradually.
- The budget for R &D, infrastructure maintenance and international cooperation is counted in 'Others' and represents 33% of the total budget for 2011.
- Launchers, developed as part of the KSLV program is the third budget line with 23% of the total in 2011. **The investment in the launcher program is expected to increase significantly** as the country plans to start the development of KSLV-2. It is expected that the KSLV-2 budget will absorb about half of the funds over the 5-year period.
- Meteorology was 5% of the total budget in 2011. After the launch of COMS-1 in 2010, South Korea started in 2011 the development of COMS-2 that will include two satellites dedicated to meteorology. **The budget for meteorology is expected to increase to 23% of the total funding** during 2012-2016 up 18% from the 2011 budget.
- The level of investment in satellite applications and launchers **reflects the national space objective** to create autonomous operational capabilities.
- South Korea's space science and technology program continues to remain a minor component of its overall space activities. It consisted so far of flying small instruments for ionospheric and cosmic ray studies on the KITsat (STsat) micro-satellites and alongside the primary Earth observation payloads on KOMPsat spacecraft.

South Korea
Government Expenditures

SOUTH KOREA SPACE EXPENDITURES 1995-2016



SOUTH KOREA 2011 BUDGET : TOTAL: C$208 MILLION



Profile of the national space industry

- The aircraft industry and the space industry are **94:6** in terms of production ratio, indicating that the space industry still remains weak in performance.
- Total revenues from the space industry was USD$149 million (C$181 million) in 2009. Exports from the space industry increased from KRW 8.3 billion (C$11 million) in 2003 to KRW 70 billion ($79 million) in 2006.
- While there are approximately 65 companies involved in space development, few have the **capacity to develop** complete space systems or key components. Most are at the subcomponents level.
- The exception is **SaTReC Initiative**, a spin off of the Korea Advanced Institute of Science and Technology (KAIST) which has the capability to serve as **a system integrator** for small earth observation satellites. It serves mostly international clients.
- Space applications make up over 70% of the market and most of the space application is **satellite communication and broadcasting business**.
- In 2008 the total personnel of the space sector was 2,372 with 58% in industry, 31% in research institutes and 11% in universities.

Industry policy

- Space activities in Korea have mainly been carried out by government research institutes in **cooperation** with foreign companies.
- The strategy towards improvement of technological capabilities of domestic companies has been through **participation** in national space development projects. The manufacturing industry can therefore be said to operate based on a **mutually beneficial partnership** among participants rather than on a competitive basis.
- KARI has sought to commercialize data from the high-resolution KOMPsat-2 satellite. This was originally achieved through regional partners, however now most commercial activity is **centralised** by Korea Aerospace Industries, Image division (KAI Image) with regional distributors selling data under reseller agreements. Since it began selling data from KOMPsat-2 in 2007, KARI has received in total US$22 million (C$22 million) through commercialization.

South Korea space industry: key data

	Companies	Revenues %	Jobs
Satellite systems and components	Total 65 (KAI, Satrec Initiative…)	5%	Total 1,381
Launchers		3%	
Ground systems and services		20%	
Applications		72%	

Source: estimates based on Korean Ministry of Education, Science and Technology; KARI.

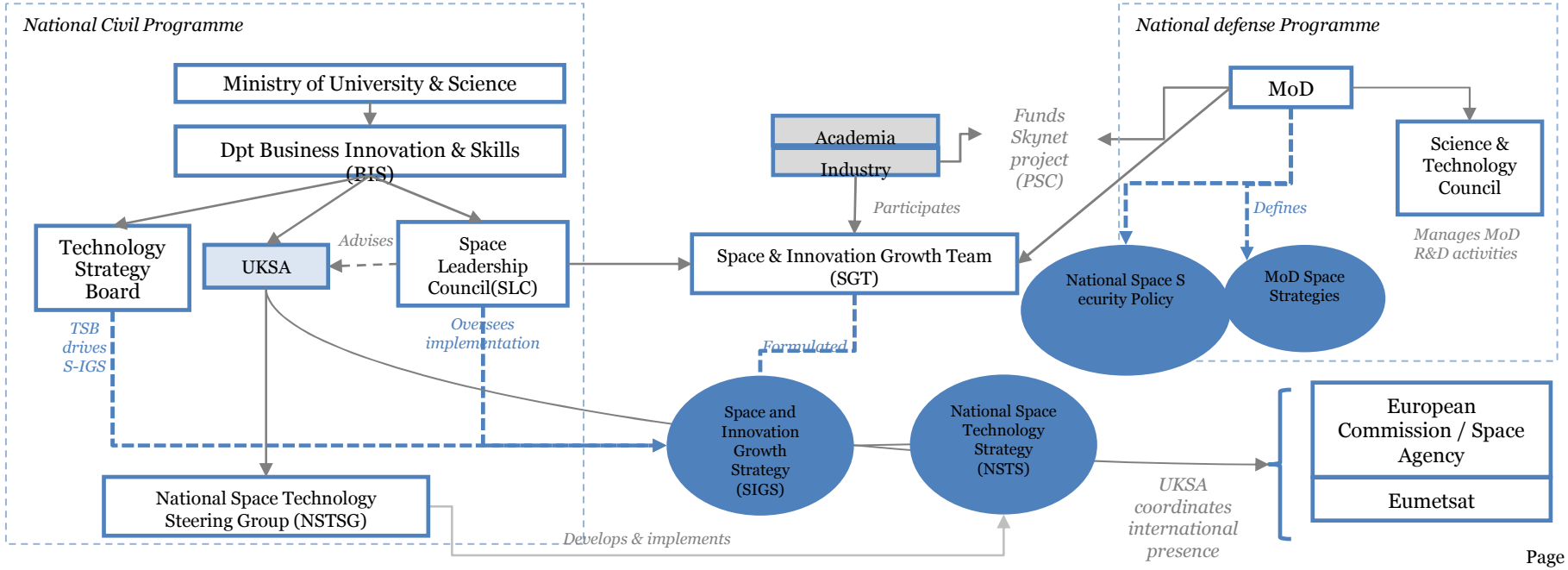
Challenges

- While many Korean companies have participated and built up their technological capabilities through national projects, the **number of development projects** connected to production units has been very limited thus far. Despite this KOMPsat 1 accomplished 60% Koreanisation and KOMPsat 3, 5 & 3A are fully home made.
- Despite KARI's stated objective of supporting industry and technology transfer, there has been **limited technology transfer** as research results are only available within KARI for security reasons.
- Due to the fact that there are few large companies that serve as total system integrators or manufacture key components, small companies cannot secure enough orders from the large firms, making it **difficult** for small companies to grow.
- Research in universities and research institutions, which concentrate on the manufacturing of space equipment such as satellites, launch vehicles and ground equipment, is **disconnected from most companies' needs**, bearing in mind that the majority of the market is in space applications.

UK
Governance of the national space program

Outlook of key government stakeholders and decision making

- Created in 1985, the British National Space Centre (BNSC) was the **coordinating body** for managing UK's civil space activities. It operated as a voluntary partnership of 10 British government departments, agencies and research councils with non-space specific interests.
- Due to a lack of focus, BNSC was **replaced in 2010 by an autonomous space agency (UKSA),** reporting to the Department for Business, Innovation and Skills (BIS) & the Ministry for Universities and Science. UKSA aims to provide a coherent approach to strategic funding & management by coordinating the UK civil space policy and steering the space plan with technical support from organisations like the Technology Strategy Board. UKSA's responsibilities include:
    1. Strengthening the UK's relationship with the European Space Agency
    2. Agreeing with UK industry on how to maximize the benefits of space technologies
    3. Working with the scientific community to provide a clear voice on decisions that affect the sector
- This recognition of the value of the UK space industry has been channelled through a joint **Space Innovation and Growth Team** (SGT) since 2009, regrouping civil and defense government, industry and academic stakeholders, which has steered the main space strategy initiatives so far.
- The Ministry of Defence (MoD) is responsible for managing the national space defense program, which has essentially focused on one single ongoing program (Skynet). Having opted for a Private Finance Initiative to run Skynet, other MoD space activities are mainly dispensed to the Defence Science & Technology Council which maximises S&T impacts for national security purposes. The MoD is the responsible entity when it comes to elaborating defense space strategies and the awaited dual use National Space Security Policy.



Space policy and strategy outline

National Space Strategy

- The UKSA's mandate is to rationalize space activities and improve on the previous space strategies issued under BNSC:
    - In 2004, the Department for Education & Skills issued a **Science & Innovation investment framework (2004-2014),** aimed at making the UK the 'most attractive location in the world for science and innovation'. It was followed by a "**National Space Strategy 2008-2012** and beyond" focused on innovation, improving quality of life, ensuring security, maintaining global scientific standing and understanding the environment.
    - In 2011, conclusions from a **UKSA** public consultation on its **2011-2015 strategy** highlighted the need for clear, timed actions to be addressed across a longer term, as well as the importance of setting advisory responsibilities and paying as much attention to research as economic growth**.**
    - Meanwhile, the Space Innovation and Growth Team (SGT) instigated the Technology Strategy Board (TSB) driven **Space & Innovation Growth Strategy (SIGS)** and the **National Space Technology Strategy (NSTS)** .
- These strategies aim to help UKSA implement UK space policy priorities, which focus on developing **technology-driven solutions** to ensure **sustained economic growth** across the UK space sector (target to increase revenues by more than six times by 2030 to £40B), by **deriving benefits** to the UK economy, environment and space science. The main **2011-2015 strategy** areas center on: export, new opportunities, innovation, science, education and smarter government initiatives. This can be achieved by:
    1. Supporting the development of space technology across all main application areas (satcom, EO, satnav, exploration/robotics, launchers) and support the concept to demonstrator phases using international support (ESA, bilateral or where appropriate).
    2. Making better use of resources by identifying common requirements and considering dual-use capabilities. This includes facilitating and encouraging academia-industry partnerships throughout the technology development cycle or maximising private financing by assisting in risk reduction at the early stages of development.

ESA (and EUMETSAT) programs

The UK has been focusing on technology-driven framework activities such as ARTES in the aim of investing on technologies with potential implementation benefit in the UK. UKSA's creation has boosted the country's involvement in ESA, particularly through the creation of a leading new ESA centre, through 4 main application areas :

- Space science: in 2009 the UK established a **ESA Science & Innovation Campus (HSIC)** including robotic technologies as a commitment to continue academic involvement in delivering instruments for ESA missions. It will also focus on deriving new applications from space data & images, climate modelling and the development of innovative technologies.
- Earth observation: supporting downstream industry through **EO Envelope Programs**, stimulating UK companies & scientific institutions, as well as preparing for and contributing to an operational **GMES** environment. Through the Meteorology Office, the UK is also heavily implicated in EUMETSAT activities and plays a leading role in climate modeling research through leading institutes (e.g. UK Hadley Centre).
- Satcom: A**rtes 4** involvement dominates due to its focus on the development, qualification & demonstration of space products and **Artes 3** enabled the implementation of the Hylas broadband success story as part of the vision for delivering a national digital infrastructure.
- Exploration: the UK plays leading roles in delivering **ESA's Cosmic Vision**, contributing to the 2012 pathfinder mission and to Exo-Mars.

UKSA programs

The main priorities over the past decade and as of today are predominantly space science & technology, and to assist national industry in maximising business opportunities:

•Space science & exploration: besides a planned **national lunar mission**, UKSA is bilaterally involved in BepiColumbo and the Indian lunar mission.

•Technology: growing interest channeled through a new **Space Innovation Centre (ISIC)** and new applications (e.g. miniaturisation & launch vehicles)

•Earth observation: sustaining expertise for **building EO satellites** (through SSTL), maintaining international standing including through developing **expertise centres** in support of environment/climate change initiatives (e.g. National Centre for EO).

•Satcom: upstream & downstream technology-driven activities are driven by the NSTS, banking on consistent levels of **R&D** to deliver customized innovative solutions.

Defense programs

The UK has acquired over 3 decades worth of involvement in manufacturing and operating defense space systems, both within an international framework and more recently focusing on domestic and dual-use purposes. The driving forces behind the UK's reliance on its domestic Skynet satcom system has shifted from being an institutional activity to a more sovereign-led priority, yet open to allies and 3rd parties, due to an unwarranted need for continuous dedicated MoD capacity.

•The UK's defense space program begun in **1987** when **NATO** selected British Aerospace to build a pair of NATO 4 communications satellites to provide military and diplomatic links among member countries. Working with BAE as prime subcontractor on the NATO 4 project, Marconi Space Systems was responsible for the communications payload.

•The UK MoD later procured three **Skynet 4** Stage 2 satellites, replacing existing models as they retired, ensuring these would be **interoperable** with the **French** Syracuse military satellite system, allowing users to access either satellite system with one set of ground equipment. Until then, the MoD had relied primarily on US and NATO satellites to communicate with its worldwide land and sea forces and during the Falklands war, British forces resorted to transmitting messages by way of the civilian Inmarsat system.

•In 1998, after considering both a Private Finance Initiative (PFI) and a pan-European system (Trimilsatcom) to replace the entire Skynet 4 fleet, the MoD decided to develop on its own the **Skynet 5** follow-on system, to ensure due system replacement timing. **An innovative PFI model** was adopted under which Paradigm Secure Communications (PSC) finances, develops, operates and owns the satellite and ground systems, providing the services to the MoD under a 20Y contract,. The company also serve other government customers on a commercial basis . **This marked the first time a government relied solely on a PFI for its secure military satcom**.

•The **Defense Industrial Strategy** (2005) by The Secretary of State for Defence proposed that a sovereign ability to design, build and operate small satellites could help foster a balanced relationship with other nations; that year the observation Topsat satellite was built, based on the internationally successful SSTL bus, exported to many nations for civil & commercial purposes.

•More recently, a **strategic defense and security review (2010)** submitted to Parliament by the government recommended the establishment of a **National Space Security Policy** to coherently address both military and civil aspects of the UK's dependence on space. This Policy was still being discussed in early 2012 amongst government stakeholders.

UK
Government Expenditures

Funding strategy

- After a **15-year period of overall stability**, at around £250-350m (C$552.5-773.5 million) per year, the UK's investment in space started to rise in 2005 under the combined effect of increasing ESA investments and the next round of long term stable defense program financing.
- Since then, **space expenditures have experienced significant growth** (+23% in 6 years) reaching £462million (C$715 million) in 2011, split between civil (70%) and defense (30%). This growth is mostly related to a continued drive by BNSC to help SMEs take part in ESA missions - deemed a more efficient way to gain a return on investment.
- UKSA's investment in space will be targeted at areas that have the greatest potential for delivering economic benefits, scientific excellence and national security. **ESA programs** and **PPPs** projects are preferred schemes,
- However, owing to its newly formed status, pending strategy and the country's economic context, uncertainties persist as to its future funding in the near term.

Funding trends by programmes

•**ESA programmes have always been the primary area of funding**, They received even increasing allocations over time as per the national S&T strategies. The establishment of the dedicated ESA Science & Innovation centre (2009) is set to further drive funding in the future, estimated to approximately double from £130million (C$299 million) in 2005 to around £250m (C$400 million) over the next few years.

•National civil funding stagnated at around £60m until the start of the economic crisis (2008), dipping 25% over 3 years until the creation of the new agency. UKSA's creation is expected to revert this trend, **with up to £100 million (C$160 million) per year by 2015** (50% government and 50% industry) unless it becomes hampered by the ongoing reduction of public expenditure related to the economic crisis.

•Defense spending has been largely influenced by the development phases of the military satellite communications system (Skynet). The Skynet-5 **PFI funding smooth government funding over 20 years** at an average of £110million/year (C$176 million) . EO and technology funding are thought to be constant, totalling around £11million/year(C$17.6 million) following the 2005 launch of the 1st high resolution British-built (and low cost) microsatellite.

•**Future spending is expected to be essentially driven by European program funding**, with UKSA reaffirming its commitment to ESA at over twice national levels of civil expenditures.

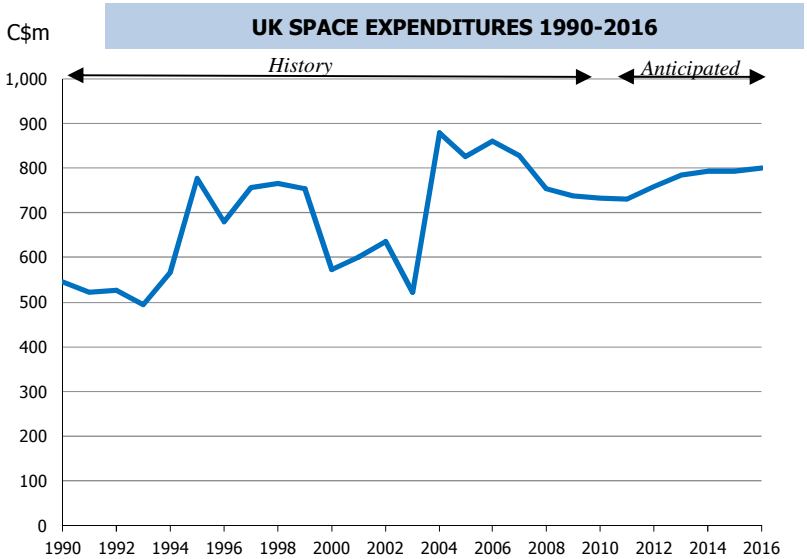
Key investment areas

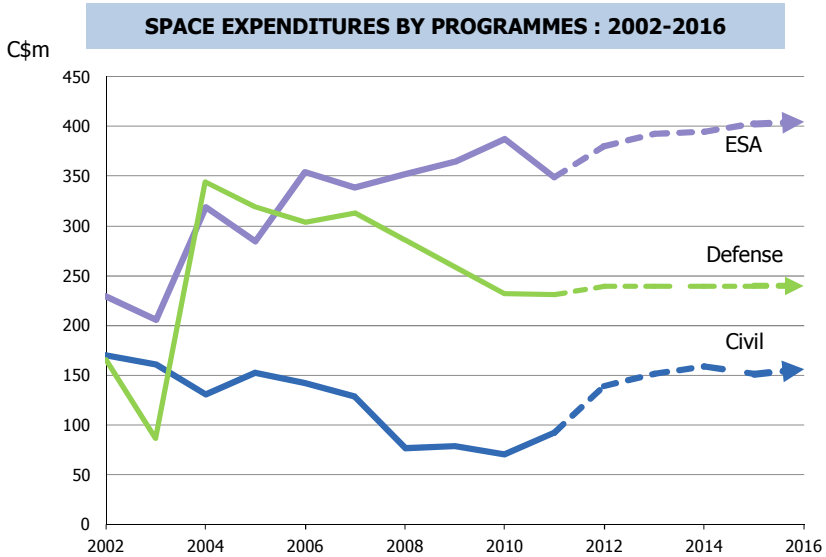
•Space science (including technology at civil level) and exploration (ESA-driven) have both witnessed 10% growth over the past 5 years, driven by the NSTS, into: developing technology (e.g. robotics) & instruments for ESA missions, as well as related services and applications.

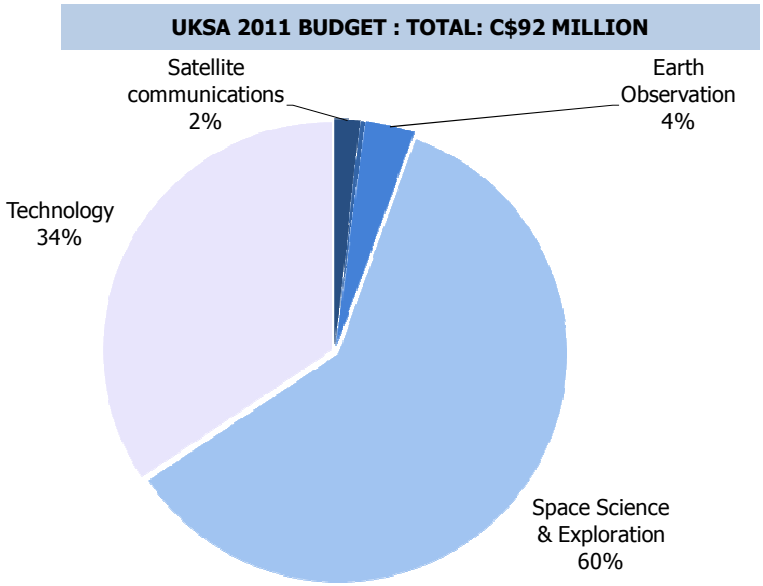
•EO & meteo: GMES participation amounts to €153million (C$244.8 million)over 2010-2014 and comprises >1000 jobs while national EO instrumentation & excellence centres are set to continue at a lower, yet stable, level. Additionally, contributions to EUMETSAT, channeled through the Met Office, constitutes a key ongoing priority.

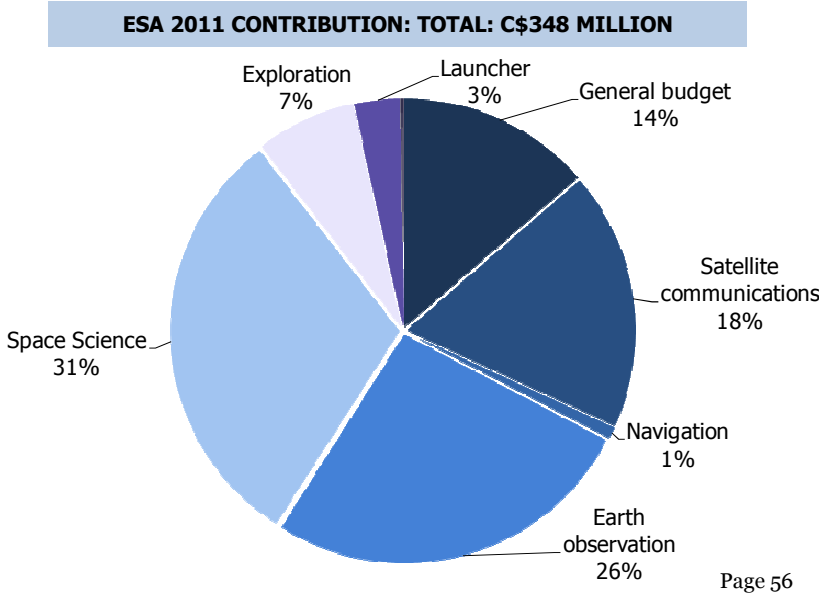
•Satcom is essentially driven by the long term military Skynet system, providing essential services beyond 2020. ESA ARTES R&D involvement ensures UK industry retains high-tech strengths and that benefits can be generated to serve UK society needs (e.g. bridging digital divide).

UK
Government Expenditures









Primary data: UKSA, Skynet, ESA

UK
Industry policy

Profile of the national space industry

- The UK economy has developed to become service driven, with **the downstream sector accounting for 80% of total space revenues.** The space industry grew around 9% per year in the UK prior to the economic crisis.
- **260 companies** are actively involved in the space industry, with the South East region concentrating >90% of the employment.
- Astrium Ltd's 2 sites (Portsmouth & Stevenage) accounts for ~60% of all jobs
- The spacecraft & satellite equipment sector appears more fragile and limited, despite being connected to the commercial and export world and comprising leading contractors, e.g. (EADS Group).
- There is also a large active industrial presence involved in support services (Logica, Serco, Vega, SciSys) and satcom services (Inmarsat, Avanti).
- The UK space industry is also strong in the ground segment market although it remains highly dependent on ESA and domestic military space programs.

Industry policy

•**Partnerships between Government and industry** are favored o support government priorities while enabling to generate revenues,

•Government initiatives have **supported the development of key national players** in the market: Skynet 5 PFI for Astrium/Paradigm, the Disaster Monitoring Constellation' international partnership for SSTL, the Hylas Broadband project financed in PPP through ESA for Avanti,

•The downstream industry contributes a highly skilled labor force necessary to deliver a healthy UK space industry, thanks to leading science & technology organizations, like the Rutherford Appleton Laboratory or QinetiQ.

•Upstream, building British spacecraft is seen as a way to maintain manufacturing revenues domestic thanks to 2 main prime contractors (SSTL & Astrium) and instrument/component companies (e.g. E2v).

UK space industry: key data

	Companies	Revenues	Jobs
Satellite systems and equipments	Astrium, SSTL, Cobham	« Upstream »: £1 billion (C $1.6 billion)	« Upstream »: 7,300
Satellite operation	Inmarsat, Avanti	£ 1.05 billion (C $1.6 billion)	1600
Ground systems and services	Logica, Serco, Vega, SciSys	« Downstream »: £6.5 billion* (C$10.4 billion)	« Downstream »: 17,600

Source: Estimates based on UKSA (2010), Inmarsat & Avanti figures (2011)
*satellite broadcasting provision revenues constitute 68% of downstream revenues

Challenges

•Although science was spared spending cuts during the crisis, **significant R&D targets will not be met** by 2014, potentially impacting on industry/universities.

•The Space-IGS recommended doubling spend on ESA programmes, but the government has stated that it **cannot commit to such funding.**

•With this economic pressure in mind, the defense ministry has been evaluating ways to maximize the use of existing networks and looking for ways to incorporate emerging technologies and techniques (hence Skynet-5 R&D considerations). The PFI model has help diminished UK expenditure by transferring part of the risks and financing of Skynet-4/5 to the private sector.

•Collaborations with allied operations have also been part of wider defense talks, notably with France, as have dual-use civil/defense concepts (through the potential establishment of a joint National Space Security Policy).

Governance of the national space program

Outlook of key government stakeholders and decision making

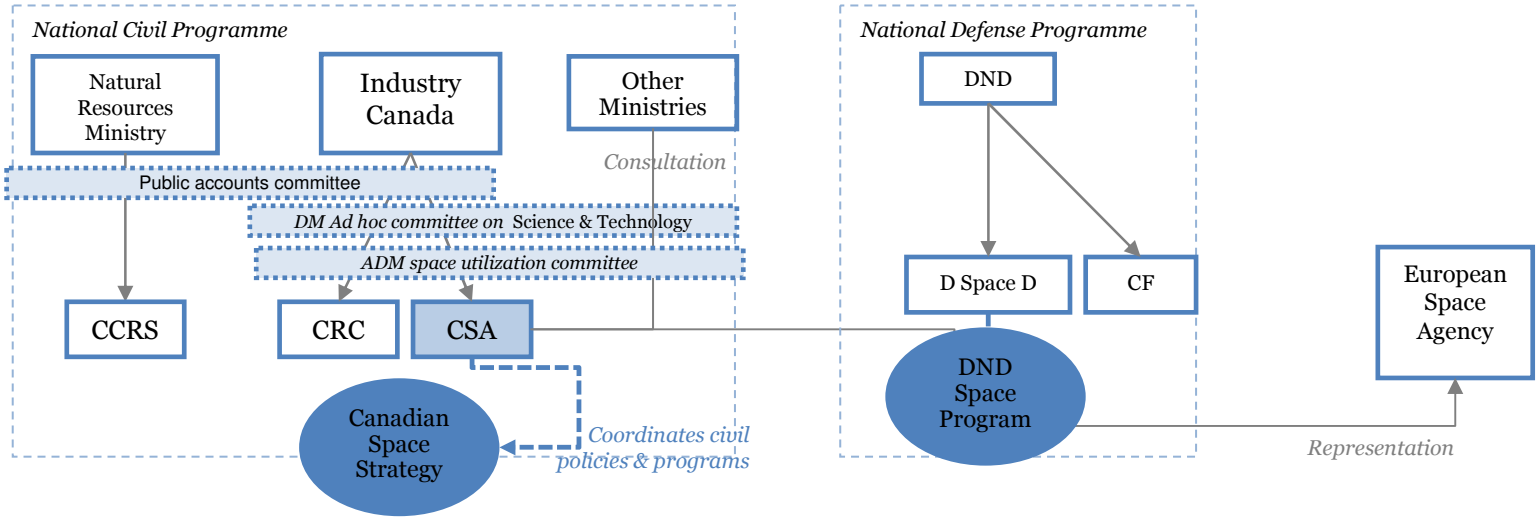
•The Canadian Space Agency (CSA) was created in **1989** to "promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians".

•The national political landscape changed in **2006** with the election of the Conservative Party after 12 years of Liberal governments. Current government policy priorities are noticeably different; particular emphases on Defense & Security as well as Arctic sovereignty being most relevant for space.

•**The Minister of Industry** is responsible for the CSA and the Communications Research Centre (CRC). CSA is responsible for coordinating all federal civil space-related policies and programs encapsulated in a national space strategy, as well as international cooperation. In particular, the CSA has played a leading role in the formulation of the national space strategy and policy. The CRC conducts leading edge R&D to develop the Canadian communications infrastructure and to support national telecommunication firms.

- Other ministries have increasingly become interested in space matters, such as Environment Canada or NRCan's Remote Sensing centre (CCRS) which receives, processes and disseminates remotely sensed data for Canada.
- Cross-departmental consultations and committees are held to help coordinate the Canadian space programme such as the Deputy Minister *ad hoc committee on* science & technology, but not as a permanent /fully integrated interdepartmental body,
- In April 2011, CSA launched a **Program Activity Architecture** framework to map its integrated future governance and funding priorities. Expected to be reviewed in 2012-13, it considers 3 working levels: Strategic level, an Investment Planning level, and an Investment Implementation level.

•**The increasing role of the Department of Defense** (DND) in the national space program led to the re-establishment of the Directorate of Space Development (**DSpaceD**), which coordinates and oversees the DND Space Program. The Canadian Forces (CF) has 6 core missions to defend Canada, North America and contribute to international peace; to accomplish this it comprises 4 operational commands & 3 environmental commands (Navy, Army & Air Force).



Space policy and strategy outline

National Space Strategy

- **The national space strategy has been developed at the space agency level**, not ministerial level. In the **1980s and 90s**, the **CSA** wrote **3** successive **Canadian Space Strategies**, which steered the Canadian space program through a successful period of achievements that included building Canadarms, launching 2 Radarsat satellites and helping build an international reputation with the International Space Station. The last of these strategies was in 2005, focused on building key capabilities across three main areas:
    - Advanced **communications** focusing on broadband, navigation, Search & Rescue
    - The flagship EO **radar** program, Radarsat, but also other developments amidst concerns regarding security & sovereignty, environment (climate change), energy & natural resources (prospecting and management).
    - **Robotics**, through the development of the Canadarm, and wider space science & exploration activities to spur innovation, security & energy applications, international relations.
- In view of the increasing interest in space amongst government departments, the CSA started to prepare a **Long Term Space Plan** (**LTSP**) in 2009. The absence of political endorsement led the proposition un-followed. **The failure highlighted governance issues on the space program and created frustrations within the national space sector** that waited for long term visibility and priorities.

CSA programs

- CSA priorities have been guided by a selective approach to develop pioneering position in space technologies. More recently the agency has **moved from a technology driven approach to a user driven approach** with the aim to serve government users needs.
- DND has become a major partner for CSA to support/co-fund dual use projects highlighting DND's increasing interest for space-based assets.
- Observation: has become a leading application thanks to the **flagship operational radar missions** (**Radarsat-1 & -2**). This will be also true in the future with Radarsat follow on mission (Radarsat Constellation Mission - RCM) and the development of Arctic dedicated operational weather services with the Polar Communication Weather mission (PCW). Other activities include research-based environmental missions concentrating on atmospheric payloads (Scisat, MOPITT, OSIRIS).
- Science & Exploration: **Space Science and Exploration thrust** (SSE) identifies **robotic** systems as a key leverage for space science and exploration by capitalizing on past investments in the field, and by securing Canadian participation in future international initiatives. Dedicated scientific and technological expertise has been used both to support all-Canadian projects and to leverage Canadian participation in larger international programs, such as the U.S.-led Phoenix mission to Mars.
- Technology: activities focus on the Technology Demonstration Program for providing flight opportunities using technologies developed by industry (M3MSAT, microsatellite platform such as that for the CASSIOPE hybrid mission for space weather and communications).
- Satcom: focused on the development of pioneering technologies to support industry's competitiveness and government needs (especially broadband technologies). The national satellite communications program has become of less a priority in recent years and now very much oriented towards the development of Arctic dedicated communications services with the PCW mission,

ESA programs and other international partnerships

•Following a review of the partnership with ESA in 2008, the **framework was renewed in 2010**. However, **Canadian participation to ESA programs has decreased over time due to decreasing budget and more focus on national users requirements.**

•ESA participation enables Canada to leverage its resources while sharing technical expertise, knowledge, and infrastructure. Canada has focused on 4 application areas, led by EO & satcom:

- Earth observation: participation in Envisat (space & ground segment equipment) and providing support to the scientific exploitation of SMOS data.
- Science & Exploration: contributions to the ISS (e.g. Canadarm) and various missions (HERSCHEL, PLANCK, PROBA-2) mainly hardware-related.
- Manned spaceflight: 5 current astronauts have succeeded 7 retired ones to the ISS with a mission to develop, support, train and fly on international space missions, and to help advance scientific research and advanced technology development.
- Satcom & navigation: ARTES involvement dedicated to long-term technology studies and the development of the Galileo infrastructure.

•Longstanding bilateral cooperation with NASA and other agencies has also been key for maintaining tangible and reliable international partnerships; it also has commitments to the Global Earth Observation System of Systems (GEOSS) & the International Charter for Space and Major Disasters.

Defense programs

•The DND **2008-2030 Future Security Environment** paper highlights the long term C4ISR capabilities expected to be supported by space components. In order to implement this strategy, DND has pursued a collaborative effort with the CSA for the development of dual use capabilities and with allied partners for defense specific capabilities.

• Dual use / co-funded projects with CSA has been successfully undertaken in various domains:

- **M3MSat** project was developed in cooperation with CSA as a cost-effective way to support maritime traffic identification.
- **NEOSSat** (Near Earth Object Surveillance Satellite), to in surveillance of asteroids that pose a collision hazard with Earth and innovative technologies for tracking satellites in orbit high above our planet.
- **Polar Epsilon Project under which DND** becomes one of the largest users of SAR data in Canada together with Environment Canada.

Future projects include in particular **the PCW** mission, planned around 2018, under which DND would benefit from a wide range of operational communications capabilities in the Arctic,

•DND also relies on 3rd party capabilities; collaboration with the US has been established as a long term strategy:

- DND signed an agreement with the US DoD under which it will get access, for a 12-year period, to capacities from DoD's Advanced Extremely High Frequency (**AEHF**) satellite system. The program plays into a larger strategic objective to increase interoperability with the US.
- Discussions are under way towards participating in the Wideband Global SatCom (**WGS**) program with Canada's acquisition of the 9th satellite of the constellation, called Mercury Global.

Government Expenditures

Funding strategy

- For **nearly 2 decades** (1990-2008), the Canadian space budget **averaged C$300million**, dipping only slightly between 1994-2000. The Canadian space program has had to deal with tight financial resources due to permanent budget tensions and an increasing focus on austerity and accountability measures.
- After two exceptional investments received from the government since 2008, **total funding for both civil and defense programs is estimated to have nearly doubled to an all time high of C$580million in 2011**,, driven by :
    - C$110 million to be spent in 2009-2011 from **Canada's Economic Action Plan**, including a stimulus initiative focusing on the robotics and Exploration Surface Mobility projects such as the Mars Lander and Lunar Rover.
    - C$397 million allocated by the 2010 Canadian budget over the next five years for advanced research, technology development and construction associated with the **RADARSAT Constellation Mission** (RCM).
- However, **the national space program is set to come back to drastic funding allocation**. The 2012 Federal Budget imposes C$5.2 billion in savings including selected cuts on science, research and innovation with its objective of steady deficit reduction. Space will contribute to this effort as the Federal Government funding for civil space activities will fall by 25% due to the end of the funding boost from the Economic Action Plan and up to C$30 million in extra savings required on CSA regular budget (planned to drop below the $300 million mark).

Funding trends by programs

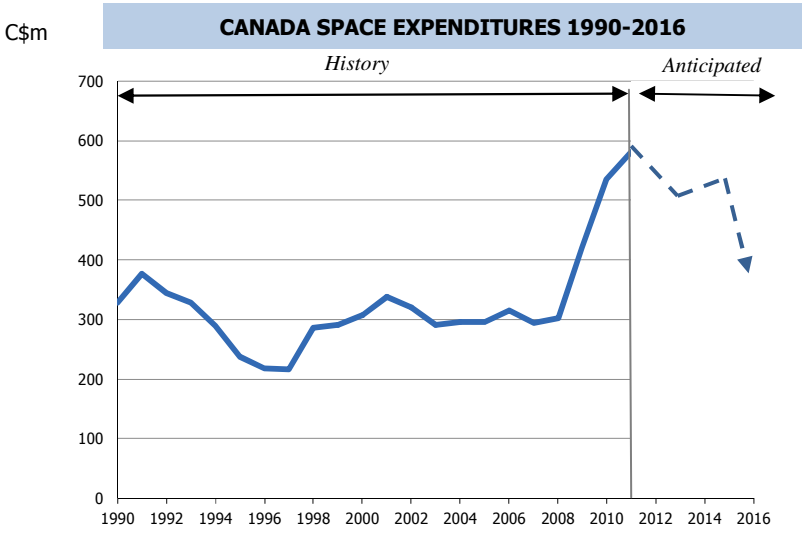
- The national civil program increased by 7% CAGR over the past 5 years to C$395million, primarily to fund **RCM** and **Canadarm**. After **peak spending in 2011 (C$395million**), future civil space spending is expected to face important cuts. The development of ambitious projects such as RCM and PCW will require significant investment commitment, but their **funding structure remains undecided**.
- **Contributions to ESA have steadily decreased in proportion of the national space programme** challenging the position of the country within ESA's programmes,
- DND has provided a significant boost in Canada's overall funding profile for space, with increasing involvement in space-related activities. Partnerships with the U.S. DoD for satellite communications would represents C$1 billion investment over the decade, a major step when compared to the past, **escalating the proportion of defense within the overall national investment in space activities**. However, this investment remains short-term oriented and not directed at the Canadian space sector.

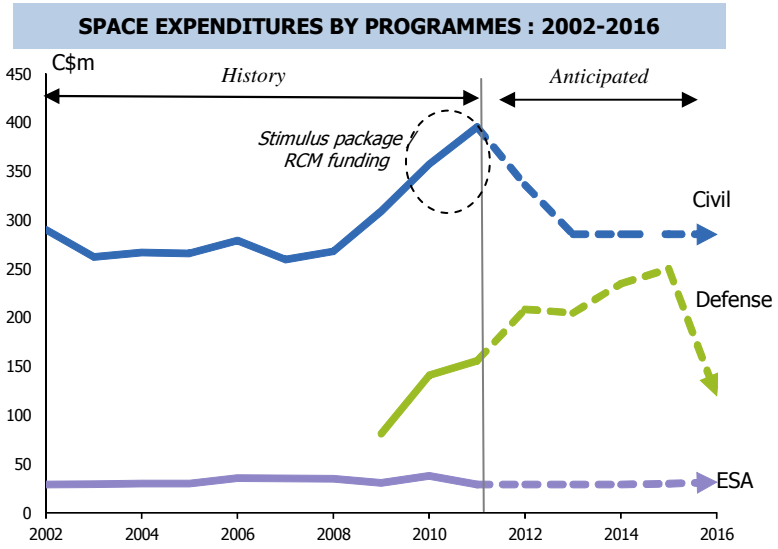
Key investment areas

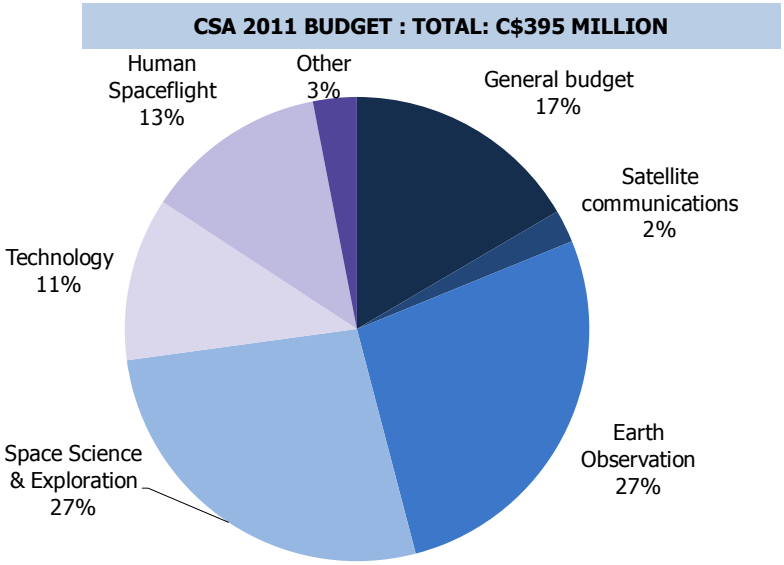
In 2011, three areas dominate the Canadian space budget which has consistently covered 5 application areas plus a general budget:

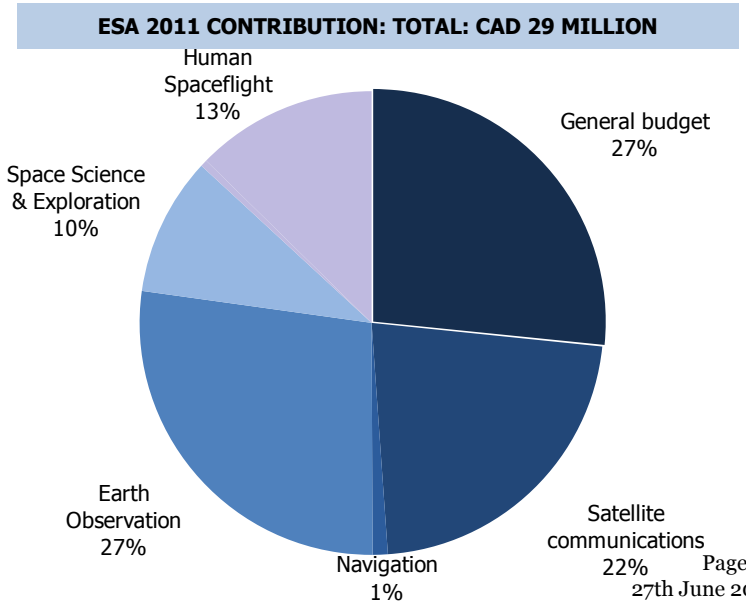
- **Earth observation**: the core of the national space program is civil-oriented – representing 80% of the C$130m invested in EO – largely dedicated to the RCM program. This peak, the highest since 1993, should be over passed in 2012 when RCM receives the majority of its funding. Other interests consist in international collaboration in atmospheric application missions (ODIN, MOPITT, Terra, ClimateSat) and considerations towards a dedicated meteorology mission, PCW.
- Satcom investments totalling C$122m are 90% **dominated by defense interests** which have become of increasing importance (since 2008), recently materialising with AEHF and WGS. Long-standing participation in ESA's ARTES programs has also sustained technology-led developments, benefiting industry.
- Space science & exploration represent 20% of the budget (C$109m), with CSA focusing on robotics and lunar/Mars programs, as well as space weather science (CASSIOPE); minimal (3%) participation in ESA and bilateral activities (SWARM; ASTROSAT).
- A general budget (13% of total) of C$73m has been increasing over the years, marked by a 1st investment towards ESA's general budget.
- Human spaceflight activities gradually decreased with ISS continuity developments, having essentially focused on robotic technology.

Canada
Government Expenditures









Industry policy

Profile of the national space industry

•The Canadian space sector accounts **150-200 companies**. A few commercial companies dominate the market (MDA, Telesat), with 30 of them accounting for the majority of revenues & skills force.

•The Radarsat programme has allowed MDA became one of the world's few integrated players able to provide solutions across the value-chain.

•Revenues increased by 14% between 2009 & 2010, reaching **C$3.4 billion** and continuing the upwards trend of the last few years (+**38% over 2005-2010**).

•The downstream sector accounts for 80% of these revenues driven by Satcom services.

•Domestic and export revenues represented an equal share (50% each)

•Contrary to other leading countries, leading Canadian space industry players are **disconnected from larger aerospace players (no aerospace conglomerate).** Many Canadian players remain pure players in space.

•Most segment of the space industry remain dominated by a single/handful number of key players **creating a risk of overdependence** regarding the supply of potential critical space-based products and services.

Industry policy

•The Canadian space programme is currently **not driven by an industry policy:**

- The CSA implements and coordinate aimed a programme at serving government needs.
- Industry Canada has not developed an integrated policy approach with respect to the Canadian space industry.

•This result in the **absence of a coherent industry strategy** to sustain/develop/create space-based capabilities.

•CSA programs have supported the development of critical capabilities with the objective to position the industry in **pioneer technologies** (broadband, robotic, radar).

•The **Canadian content regulation** protects Canadian industry players in their domestic government market and prevent from purchasing foreign solutions.

•The **Canadian government decision to block the ATK take-over of MDA** has been the first case of its direct intervention in industry M&As showing highest political concerns in protecting key domestic space capabilities

Canada space industry: key data

	Companies	Revenues (C$m)	Jobs
Satellite systems and equipments	75	623	Total: 7500 (2011)
Satellite operation	Telesat	821	
Ground systems , applications & services	70 (ground) + 80 (applications) + 150 (other/research)	2770*	

Sources: CSA state of the Canadian Space Sector (2010), Canadian Space Commerce Association (2011)

* Includes space research and assumes satellite operation revenues.

Challenges

•The C$110 million funding from **Canada's Economic Action Plan** demonstrated Federal government objective to protect robotic capabilities. However, it also created an **artificial short term growth** immediately followed by significant cuts across the space programme, affecting domains relying on government R&D support.

•**Lack of large domestic market** forces Canadian industry players to go to the international market but with a **competitive disadvantage** compared to leading competitors that benefit from wider local support.

•Difficulties for the Canadian industry to translate a pioneer position into **leadership** in the market.

•**Risk to see the industry splitting** into those essentially relying on government contracts and those developing commercial capabilities with little interest in partnering with the CSA.