Space Transportation Systems – Demand / Market Analysis

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Abstract

For this paper the demand or market for space transportation systems has been analyzed with special regard to the European family of launchers. A segmentation depending on customers and applications resulting in four main segments was introduced: Commercial / Institutional and GTO / Non-GTO.

It has been assumed that the entire commercial market and the European institutional market are accessible for European launchers. Non European institutional markets are accessible only partially and the accessible part is regarded as commercial market.

The market analysis revealed the following results:

- GTO market is mainly commercial and is expected at 20-25 sats/year, resulting in a launch business volume of 1.1 B€ per year. Arianespace has the potential to win 40-60% of this, i.e. some 4-7 launches (Ariane 5 & Soyuz).
- Predictions for the increase rate of GTO sats mass show uncertainties. After a stagnation in the 2004-2007 period the average mass of GTO sats may grow again beyond 2009 by the recovery of heavy sats (> 6 t).
- The return of Chinese launchers in the commercial market is the major uncertainty for the launch price evolution.
- The 2007-11 average yearly European institutional demand comprises ~10 payloads and asks for 4-7 launches:
  - 1 - 2 Ariane 5
  - 1 - 2 Soyuz (Starsem, launched from CSG starting 2009)
  - 2 - 3 Vega class (Vega starting 2009, Rockot, Cosmos, Dnepr, PSLV)
- Ariane 5 is most important for the European institutional launch demand volume share (60%).
- Europe has no yet developed a common (political) vision for Space Exploration. Mid- to long-term launch demand including potential increase of launcher performance demand and entry into manned flight capability is not yet defined.
- Suborbital space tourism market is under preparation by commercial ventures
- New space applications (orbital tourism, power from space, …) are still blocked by the vicious circle of high transportation cost and low flight rates.
- The yearly launch business volume for the European launcher portfolio is ~800 M€, ~500 M€ from the commercial and ~300 M€ from the institutional market.

Conclusions for the future orientation of European space transportation capabilities are:

Ariane 5

- GTO dual launch capability will remain a key for success
- A launch rate of 6 to 7 per year is a realistic goal.
- Issues for further evolution and competitivity are
  - Increase of launch performance: ~12 t GTO, possibly available ~2015
  - Upper stage re-ignition capability
  - $/€ exchange rate

Soyuz (at CSG)

- Will be used complementary to Ariane 5
- Low launch rate at CSG (risk for reliability?)

Vega

- Institutional launch demand 2-3/year, but with competition (Rockot, Cosmos, Dnepr, PSLV)
- Commercial competitivity will ask for institutional support (above $/€ exchange rate)

Long-term launcher development

- Europe needs a (politically driven) vision and a continuously funded program.

1 Introduction

The DGLR S4.1 Working Group on Space Transportation Systems (Fachausschuss S4.1 Raumtransportsysteme) is a forum for members from agencies, institutions, industry, and universities. Gathering and analyzing information and argumentation on space transportation systems' past, status and future is the objective of the group.
The analysis and documentation is coordinated around the topics:

- Demand / Market
- System Concepts & Subsets
- Propulsion and Structures (System related aspects)
- Missions & Operations (incl. Ground infrastructure)
- Cost (Development, Production & Operation)
- Projects / Programmatics (Development & Demonstration)

This report summarizes the status of discussion concerning the topic "Demand / Market".

2 Satellite Launch History

50 years ago, on October 4th 1957, the space age began with the launch of the world's first satellite Sputnik. Since then, the space launch rate has seen a plateau of about 100 to 120 successful launches per year from the late 1960s until the early 1990s. After that the yearly launch rate has continuously decreased to a level of about 60 launches per year today. The USA and the former Soviet Union were leading the launch rate statistics during the first decades of the space age.

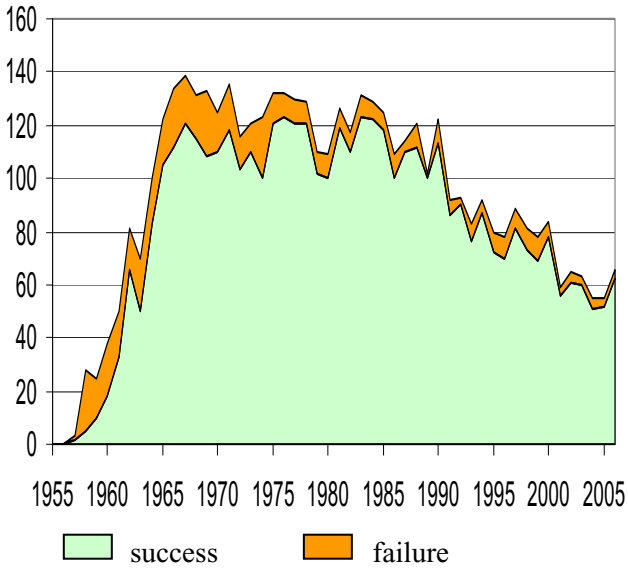

Figure 1: Number of space launches per year

3 Space Launch Market Segmentation

The space launch market can be segmented related to customers and destination resulting into the 4 main segments:

- Commercial GTO
- Institutional GTO
- Institutional Non-GTO
- Commercial Non-GTO

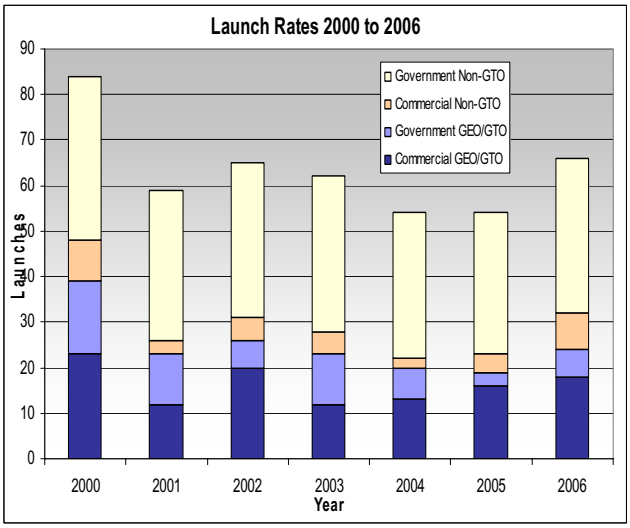

Figure 2: Launch rates for the 4 main segments (2000 – 2006)

For European launchers the entire commercial and European institutional markets are accessible. Non-European institutional markets are only partially accessible. Launch contracts are typically acquired by best value offers in a competitive environment. Therefore, this segment is regarded as a commercial market.
The following analysis is regarding space launch demand (market) accessible for European launchers.

4 Commercial GTO Launch Market

Target orbit, number of payloads / satellites and mass – average, minimum and maximum – are significant parameters to characterize space launch markets.

4.1 Number of Payloads

This launch market analysis is based on data by COMSTAC, ESA, ARIANESPACE, and EUROCONSULT. After combining the results of the above mentioned sources some general conclusions can be drawn.

The estimates for the next 3 years are quite sure due to the contracts already signed. These estimates indicate a number of about 22 to 24 GTO payloads to be launched by ARIANESPACE. These numbers may vary slightly due to shifts in the planned launch dates.
The projections for the years following thereafter are generally optimistic and show a slow progression. The ESA estimates show a significant drop in 2011 which is explained by the consideration of confirmed ESA missions for this analysis only.

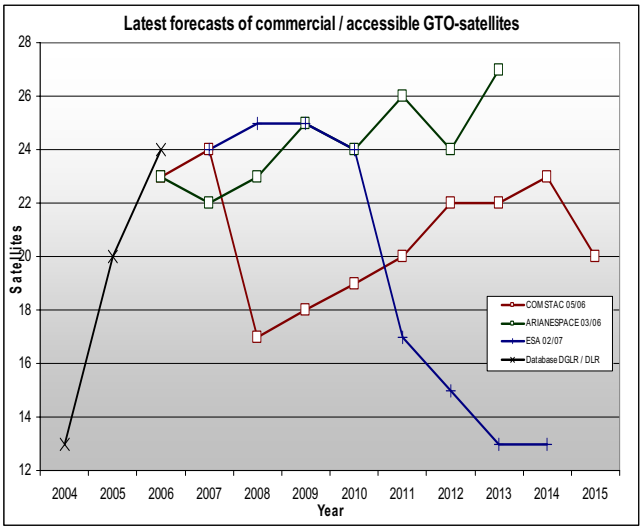

Figure 3: Number of GTO/GEO satellites to be launch in 2007-2015

4.2 Satellite Mass

Since the beginning of commercial tele-communication the average mass of satellites launched to GTO (the circularization in GEO is done by satellite imminent apogee propulsion) has significantly increased. For the last 20 years the increase rate shows an average of 150 kg/year. In detail this is not a continuous development. Steps can be identified which are triggered by the evolution of satellites (generations of satellite buses) and the availability of adequate launcher performance.
The average GTO satellite mass has not significantly increased since 2004. This value will remain stable at a level of about 4200 kg until 2008. Beyond 2009 there are indications of a new step in mass increase resulting from a recovery of heavy satellites (> 6t). The trend is not easy to predict as several constraints are influencing the evolution. There are overall economical & political constraints for the telecom business driving global and regional aspects individually. Global ventures and markets (big players) are driving the big/heavy satellites. Another constraint is the availability of sufficient launch performance (mass) and capability (numbers) including back-up solutions as customers are not eager to suffer from individual launcher problems. The available satellite insurance capital is another constraint especially for the further evolution of large satellites.

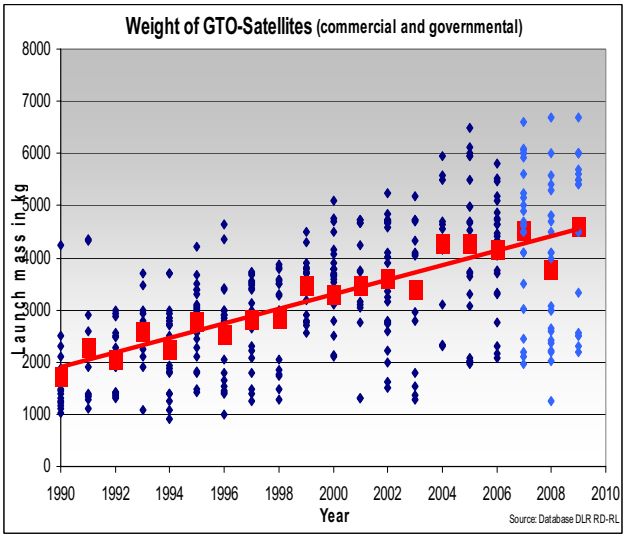

Figure 4: Launch mass evolution of GTO satellites

4.3 Launch Business Volume

The individual launch price of commercial payloads is an element of competition and therefore normally not published. But there are regular indications from customer and launch operator side showing the level of launch prices. For the discussion of launch price evolution it has to be regarded that there are typically 2 – 3 years between the signature of the contract fixing the price and the launch itself. All considerations in this report are regarding the launch date and not the contract date.
After a continuous decline of the commercial launch price level from 1997 to 2005 – mainly for launches to GTO – it is increasing now. This is the result of the recovered commercial launch demand and a reduced pressure of Russian dumping offers. The major uncertainty for future price level evolution might come from Chinese launch offers. Today China is blocked by the US-ITAR regulation. As this is a political regulation a change may occur rapidly. Like Russia China should have the possibility to offer prices independent of western standard cost calculations.
The price indication for 2006 launches was 50-60M$ for a mid-size (4-4.5t) satellite. Taking the above figure of 24 satellites launched, there results a total launch service business volume of 1.3B$ or 1.1B€ as a rough estimate.

4.4 Arianespace Market Share

The Ariane / Arianespace market share of GTO commercial satellites has been dominant (> 50%) when operating the Ariane 4 launcher (1988-2001). In the last 5 years Arianespace has suffered from strong competition (ILS/Proton & SeaLaunch/ Zenith) and from draw backs in reliability and stable operation during the early phase of Ariane 5 ECA service.
Taking into account the present uncertainty of SeaLaunch operation after the failure early this year, the exit of Lockheed-Martin from ILS launch services and the demonstrated reliability of Ariane 5 ECA, the market share for Ariane 5 and Arianespace (including some launches by Soyuz/Starsem) should significantly increase again. For short-term a market share variation of 40-60% should be realistic, indicating opportunities and risks for Arianespace in the commercial GTO launch market.

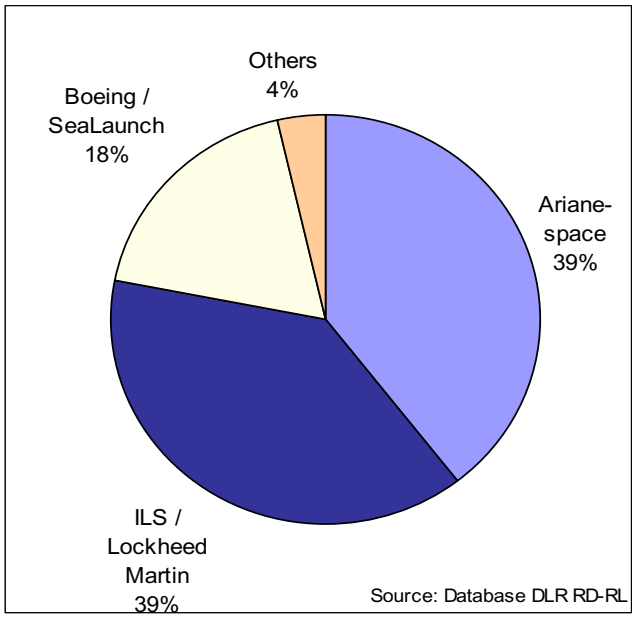

Figure 5: Market shares 2000-06 of commercial GTO launches

5 European Institutional Launch Market

The European institutional launch market is mainly based on a well established ESA science program and several national programs. The European institutional launch market is significantly smaller than the US and Russian institutional markets. This is caused by two facts:
First, the absence of an own manned space program in Europe, which results in a lack of relevant infrastructure and vehicles, and second, the limited European space defense activities, which currently perform first steps towards harmonization and concentration of national programs.
A “buy European” act for space launch vehicles – similar to the regulation in the USA – has been initiated in the ESA ministerial council in 2005 but is mainly on a voluntary basis. The ESA member states have agreed to take European launchers into account when selecting a launch system for their national payloads.
The evolution of coordination of space activities by ESA and the European Community is under discussion (Space Councils). An integration of ESA into EC is not feasible due to different member communities and variations in goals and rules – at least at present.

5.1 Number of Payloads

The yearly number of European institutional payloads / satellites to be launched has increased during the last 10 years.

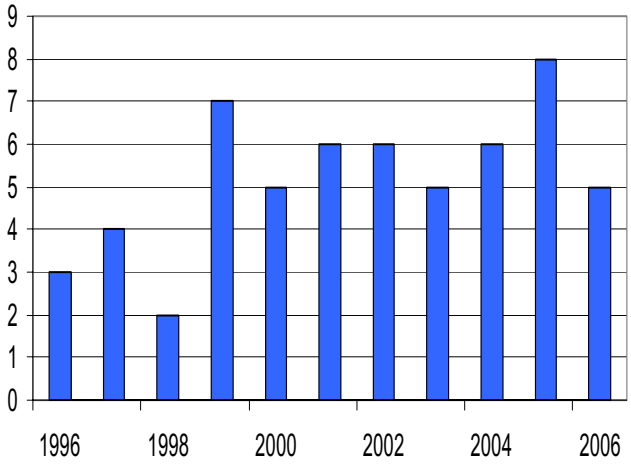

Figure 6: History of European institutional missions with number of payloads >50 kg per year

The preview for the coming 5 years (Figure 7) indicates a further increase to an average level of 10 payloads to be launched each year. Major uncertainty within the list of known and running projects results from the present replanning of the Galileo project. As the increase of European institutional payloads is resulting from a wide spread increase of European space activities - ESA, EU, and national - individual delays should not affect the overall launch demand by much more than 10%.

	2007	2008	2009	2010	2011
ESA	• Galileo/GSTB V2B (ESA/EU) • SMOS/Proba 2 • Goce	• ATV 1 (J. Verne) • Herschel • Planck • ADM-Aeolus	• LISA Pathfinder • SWARM • Galileo IOV1 (ESA/EU) • Galileo IOV2 • Cryosat 2	• ATV 2 • Galileo 1 • Galileo 2 (ESA/EU) • MSG 3 • Sentinel-1 • IXV • SGEO	• ATV 3 • Sentinel 1A • Metop 2 • MSG 4 • Galileo 3 • Galileo 4 • Galileo 5 • Galileo 6
CNES/ DGA			• Helios 2B (DGA) • MEGA-Tropiques	• Pleiades1 (DGA) • Syracuse 3C	• Pleiades2 (DGA)
DLR/ BWB	•SAR-Lupe 2 •SAR-Lupe 3 •RapidEye •TerraSarX	• SAR-Lupe 4 • SAR-Lupe 5 • SatcomBW 1	•SatcomBW 2 •TanDEM-X	• EnMAP	
ASI/ SITAB	• CosmoSkyMed1	• Cosmo SkyMed 2	• CosmoSkyMed 3 • CosmoSkyMed 4 • Sicral 1B (SITAB)	•Sicral 2 (SITAB)	
BNSC/ Paradigm	• Skynet 5A	• Skynet 5B	•Skynet 5C		
INTA/ Hisdesat					•Seosat
Total P/Ls	**9**	**9**	**13**	**11**	**10**

=52/5yrs

Figure 7: European institutional launch demand 2007 to 2011 (payloads > 50kg)

Beyond these 5 years of concrete analysis there are indications which allow for a partial extrapolation for

- ISS exploitation (ATV)
- Science program
- Galileo & GMES

Uncertainties for further reaching projections are raising mainly from

- (Slowly) Evolving European role in Space Exploration, including manned missions and heavy LEO payload capability
- (Slowly) Progressing European defense space policy.

5.2 Orbits, Mass and Business Volume

The European institutional space launch demand comprises a wide variety of target orbits and mass of the individual payloads. Target orbits are varying from LEO to interplanetary missions. The individual payload mass is reaching above 20t for ATV. At the lower end of the mass range, there is an evolving market of very small (micro, nano, …) satellites. Very small payloads (below 50kg of mass) are not influencing the launch capability evolution. Either those payloads are launched as auxiliary payloads (piggy back) or existing (small) launchers are used for multiple launches. Therefore, the following considerations - as already indicated in chapter 5.1 - are not regarding payloads below 50kg of mass.

The European institutional launch market is well defined for the coming 5 years. In addition to the list of payloads (Figure 7) the related target orbits and intended launch vehicles are known. Regarding the launch prices, this allows for definition of the launch market value and market segment.

The total European institutional launch market for 2007-11 can be estimated at nearly 1.4 B€ or roughly 275 M€ per year. 70% of it are civilian and 30% defense payloads. There can be distinguished seven sub segments of this market separated by target orbit and level of mass of single payload. The related business volume is reaching from 375 M€ to 80 M€ for the 5 years period (Figure 8):

- ATV: 375M€, dedicated for Ariane 5
- LEO/Polar/SSO sats of ~1t mass: 275 M€, for Vega class launchers
- GEO sats of 4-5t (GTO), mainly defense: 245 M€, for Ariane 5
- Galileo:165M€, for Soyuz (Starsem & CSG)
- GEO small sats, defense and meteo: 125M€, for Soyuz
- Interplanetary science (Herschel-Planck) : 115M€, for Ariane 5
- SSO big sats, civil & defense: 80M€, for Soyuz.

ATV is outstanding and the only launcher performance dimensioning mission (specific qualification Ariane 5 ES-ATV).

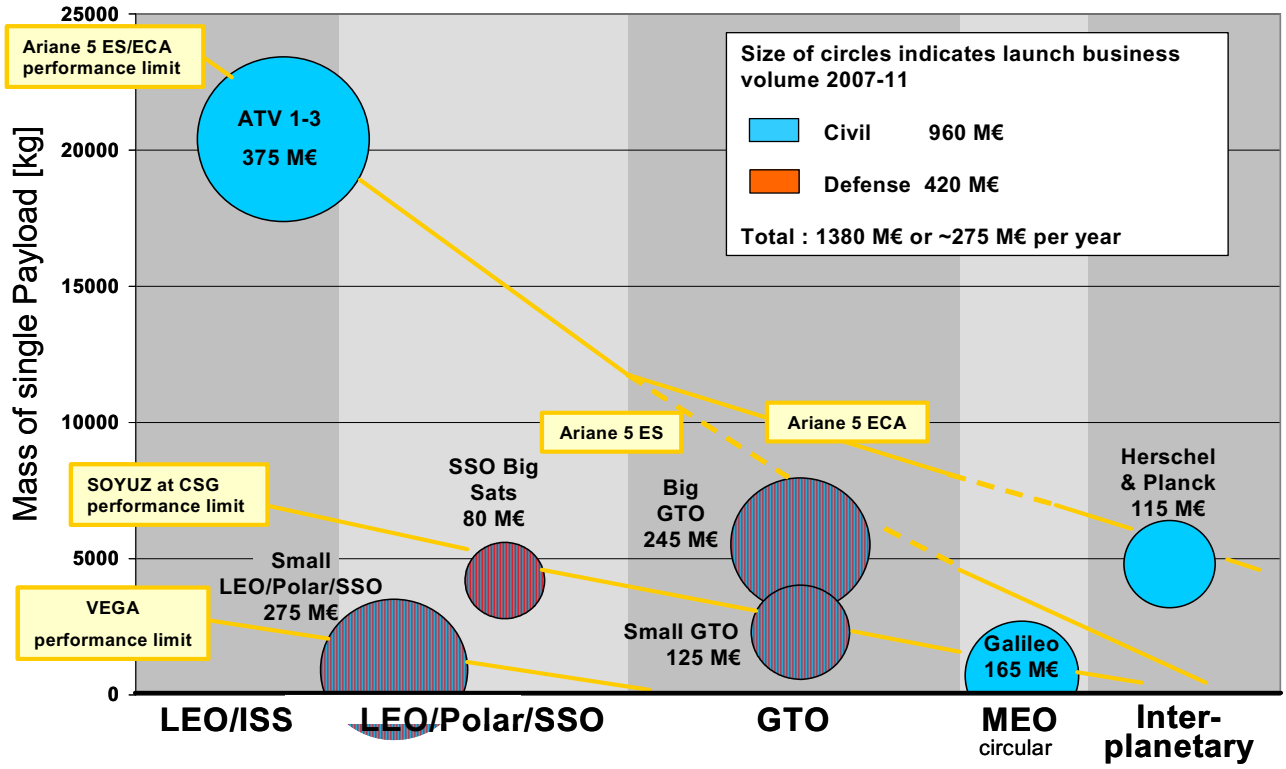

Figure 8: European Institutional Launch Demand 2007-2011

5.3 Launchers Business Shares

The detailed analysis of the 2007-11 European institutional launch market also allows for an assessment of expected shares of launch business volume for each launcher within the European launcher portfolio.

- **Ariane 5**
  - Is needed for ATV, standard GEO/GTO sats, interplanetary
    => launch volume : ~750M€
  - in addition used for GEO small sats (50-100M€)

  => Total 800-850M€ or ~175M€/yr
  equivalent 1-2 launches/yr

- **Soyuz**
  - is needed for SSO big sats, Galileo and remaining GEO small sats
    => Launch volume : 250-300M€
  - In addition used for scientific LEO/Polar/SSO sats (~100M€)

  => Total 375M€ or ~75M€/yr
  equivalent 1-2 launches/yr

- **VEGA class launchers** (VEGA, Rockot, Cosmos, DNEPR, PSLV)
  - will be used for scientific, military & coms LEO/Polar/SSO sats

  => Total 175M€ or ~35M€/yr equiv. 2-3 launches/yr

Launch market volume share
55%
5%
60%
20%
7%
27%
13%

Figure 9: European Institutional Launch Demand 2007-11 and Respective Shares of Launchers

6 Total Space Launch Market Accessible for European Launchers

A total view of the accessible launch market for European launchers can be achieved by combing the European institutional (average of 2007-11 period) and the well predictable (2007-08) global commercial market segments.
Concerning the target orbits, the GTO orbit is dominant for the launch business in Europe. Besides this there is a wide variation of orbits and payload mass. Obviously this can not be served by a single launcher, at least not cost efficient. Therefore Europe is using a portfolio of launchers:

- Ariane 5 (ECA & ES)
- Soyuz (Starsem, from CSG starting 2009)
- Vega class launchers (Vega starting 2009, Rockot, Cosmos, Dnepr, PSLV)

Their performance limits are a first indication for the market segments they can access.

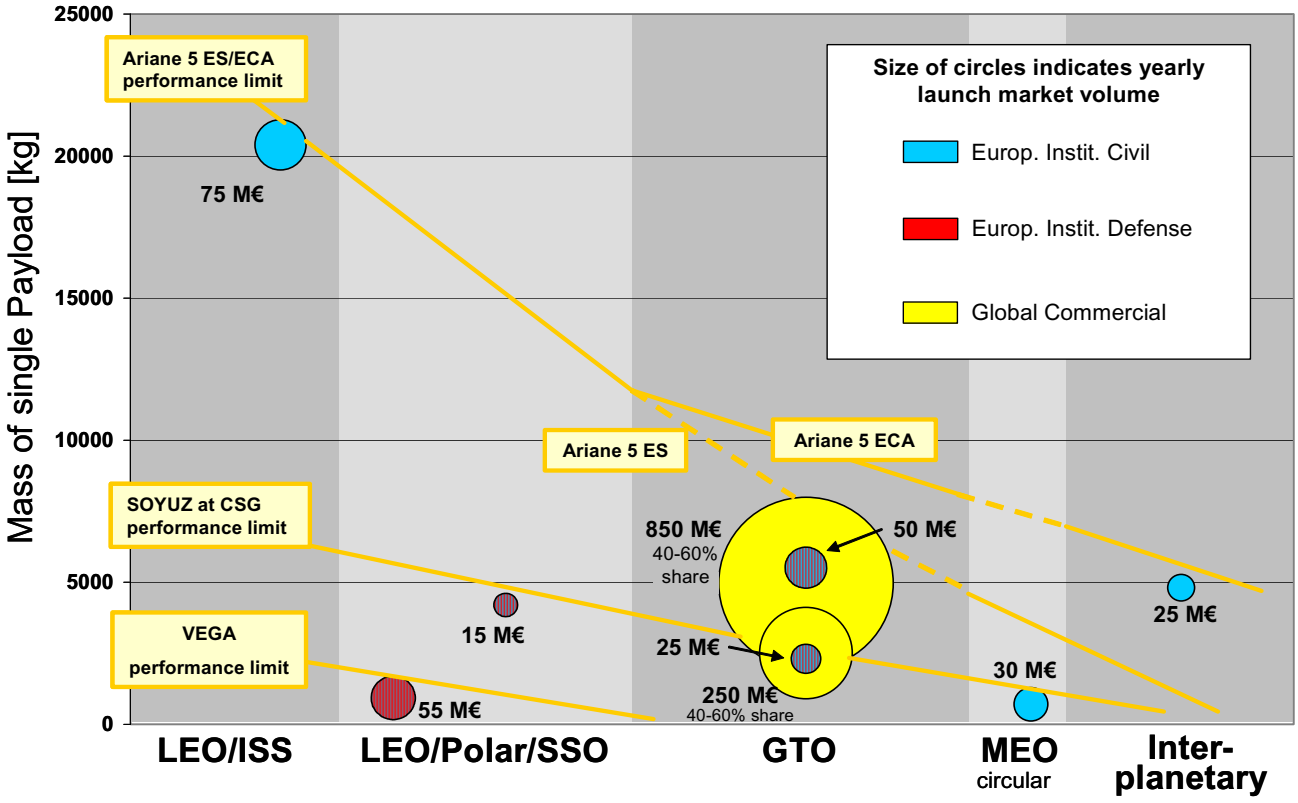

Figure 10: Space Launch Market Accessible for European Launchers

Compared to the detailed analysis for the European institutional launcher market shares shown in Figure 9, the sharing assessment for the commercial (GTO) market is quite easy. Ariane 5 should take the total segment. For the Soyuz/Starsem gap filler role no commercial mission is expected for the 2007-08 period.
The yearly launch market accessible for European launchers amounts to nearly 1.4 B€. The importance of the commercial market for Ariane 5 is obvious even when the achieved share of 40-60% is taken into account. In total the launch business volume for the European launcher portfolio is expected at roughly 800 M€. Ariane 5 should take 600-700 M€, Soyuz/Starsem roughly 100 M€ and the Vega class launchers below 50 M€ per year.

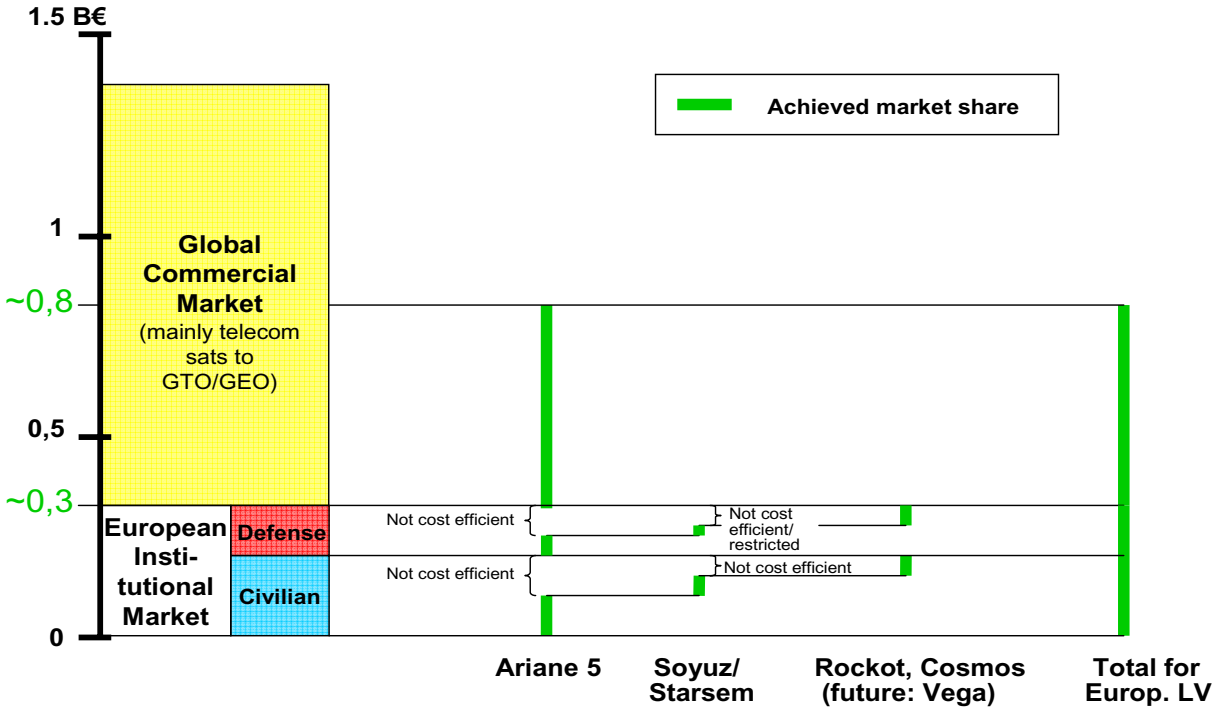

Figure 11: Yearly Space Launch Market Accessible for European Launchers and Achieved Shares

7 Summary of Market Analysis

Regarding the importance for Europe and European launchers the market analysis results can be summarized for the Commercial-GTO and the European-Institutional market segments.

GTO commercial market is expected at 20-25 sats/year. Arianespace has the potential to win 40-60% of this. Ariane 5 ECA will serve this in dual launch configuration by 4-6 launches per year. Soyuz will function as gap filler, in case the dual launch combination is not efficiently achievable. This should occur for less than one commercial payload per year. Predictions for the increase rate of GTO sats mass show uncertainties. After the stagnation in the 2004-07 period at an average of 4200 kg, a further step of increase may occur beyond 2009 by the recovery of heavy satellites. The stabilized present launch price level sees its major uncertainty by the return of Chinese launchers in the commercial market.

The European institutional market comprises roughly 10 payloads (> 50kg) per year and will ask for 4-7 launches per year. The present replanning of Galileo should not influence this preview beyond the anyway regarded uncertainty. Ariane 5 is in the position to serve all demand, but cost efficiency asks for 1-2 Soyuz (medium class) launches and 2-3 small class launches per year. Soyuz is available via the Starsem agreement and will be launched from CSG starting 2009. The small class launches are today provided by foreign launchers available via launch consortia or contracts: Rockot, Cosmos, Dnepr, PSLV, and recently also Delta 2. Vega should be available starting 2009. Ariane 5 is most important for the European institutional launch demand as it is serving 60% of the European institutional launch business. Concerning Space Exploration there is still a lack of common (political) goals and a rediscussion of European manned launch capability might occur when international manned exploration initiatives (US, Russia, China, India) will gear up. Therefore the mid- to long-term launch demand including potential increase of launcher performance demand and entry into manned flight capability has to be regarded as not yet defined.

The commercial non-GTO market has seen much attention during the mid to end nineties caused by the discussion of LEO-satellite-constellations for mobile global telecommunication independent or in combination with ground based nets. Beginning of this century the projects disappeared nearly totally. Remaining is the operation of Iridium and Globalstar. Partially, the operation is based on non-European institutional demand. Upgrade demand of these constellations is seldom and the related launch market is not of essential influence – at least for the European launchers.

Suborbital space tourism market is regarded outside of space launch market as the related launch performance and the necessary systems are fundamentally different. It is mentioned here as there might be future synergies of system and operations experience and technologies. There is no institutional support and the new market segment is under preparation by commercial ventures only.
New space applications like orbital tourism, power from space and others are under discussion since the beginning of space age. Reasonable analyses are regularly showing that the present cost of access to space is essentially, i.e. orders of magnitude too high to allow for such endeavors. But the - for such applications inherent - big traffic could be key to essential reduction of transportation cost. Today it can be regarded as vicious circle of high transportation cost and low flight rates blocking the new space applications.

8 Conclusions for the European Launcher Portfolio

The following conclusions can be drawn for the evolution of the launcher portfolio used by Europe. They are listed separately for the three categories of launchers.
Ariane 5 is the backbone for the European guaranteed access to space. The GTO market is most important for Ariane 5 and the dual launch capability will remain a key for success. For short- to mid-term future a launch rate of 6 - 7 per year is a realistic scenario for Ariane 5. Beyond that some issues have to be considered. Probable increase of satellites GTO masses and especially the recovery of heavy (> 6 t) satellites might ask for an increase of performance towards ~12 t GTO. In addition, an increase of flexibility via a reignitable upper stage in combination with high performance propulsion should help to prepare Ariane 5 for the evolution options of the GTO/GEO satellites and institutional market and related orbit injection strategies. To close the gap between commercial launch price level and the Ariane 5 production and operation cost further consolidation and optimization in the production and operations is required. The current detrimental $/€ exchange rate plays a role here, too.
Soyuz (Starsem, from 2009 launched from CSG) will be used complementary to Ariane 5. For commercial launches this would be the case where Ariane 5 dual launch combinations can not be arranged efficiently. For the European institutional demand these are cases the Ariane 5 performance (and cost) is well above the demand. Regarding this constraint the launch rate of Soyuz from CSG will be roughly 2 per year, while the overall Soyuz launch rate is about 10 per year. In general, low production and launch rates might be a risk the reliability of launchers.
Therefore, Europe has to follow cautiously the evolution of the overall Sojuz production rate.
Vega class institutional market demands 2-3 launches per year. Vega will meet a strong competition when starting service in 2009. Therefore, the launch rate will be low (1-2 per year) and there will also be the question of reliability in production and operations. In competition for European institutional payloads there will be the need to partially cover launcher fixed cost by governmental funding. Beyond this there will be the need to compensate $/€ exchange rate (like for Ariane 5) to allow for commercial competitivity.
For the long-term future Europe has to prepare for new markets and demands. The envisaged role of Europe for future space transportation is also a task for political decision. To allow for technological and system concepts preparation a continuous program and funding is necessary. At present conceptual analysis is prepared under the title of “Next Generation Launcher – NGL” and the related study and technology program is called “Future Launcher Preparatory Program – FLPP”.

Acknowledgement
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