Existing Space Access for small satellites

Future technical trends and possibilities

Space Economy in the Multipolar World SEMW2010
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CNES, Launchers Directorate (Evry, France) – M. Pons, C. Talbot
1 Launchers

- Existing launchers

- Some projects - quick zoom on MLA project

2 Future trends

- Market analysis

- Future opportunities
Europe will soon operate from French Guiana a new family of launchers:

- Ariane 5, in its last version (A5ECA) using a 14t cryogenic upper stage propelled by HM7
- Soyuz, in its “1a” version, will be first launched from Guiana in 2011
- Vega, the new developed rocket, will be launched from Kourou by end 2011

This family is adapted to European institutional and commercial needs with a complete coverage of the payloads between small to heavy payloads.
Current European offer:

Performance ranges of European launchers and projects in relation to satellite masses.
How to launch very small sats

European launchers

Ariane 5 : ASAP-A5
8x 120 kg (600x600x710mm)

Soyuz : ASAP-S
4x <200 kg (800x800x1000mm)
1x <400 kg (Ø1500mm, H 1400mm)

Vega : Vespa (devlpmt in progress…)
2x <200 kg (800x800x1000mm)
3x <200 kg (>Ø900) + 1 small mini
How to launch very small sats

**US launchers**

*Minotaur family (OSC): LV derived from decommissioned ballistic missiles (minuteman II, Peacekeeper), operational (M4&5 in development)*

Performances:
- M1 ≈ 500 kg LEO
- M2 et M3: “Target LV”
- M4 ≈ 1500 kg LEO,
- M5: GTO compatible

*Pegasus family (OSC): operational airborne LV (ORS version: Raptor-1). Ground variant (Taurus)*

Performances ≈ 200-400 kg LEO (Pegasus-XL)

*Falcon-1 (Space-X): « low cost » launcher?*

Performance ≈ 200-400 kg LEO, and until 700 kg LEO (Falcon-1E)

Falcon-1 price < 10M$ ...
US Responsive Space

Operationally Responsive Space (USA)

Responsive Space Inventory – rapid reaction capability, “Dell computer-like”

Responsive Payloads
- Mix-and-Match Sensors
- Tailorable Comm capability

Responsive Buses
- Plug n Play Modularity
- Standard interfaces

On-Demand Launchers
- Affordable
- Streamlined processing

Payload Flexibility

Bus Standardization

Responsive Launch

Tactical Operations
- Single Pass Tasking & Downlink
- Integrated with existing C2 theater assets

JFC Call-up

Rapid Assembly, Check Out and Test

Rapid Initialization / Checkout

Responsive Launch
- Rapid Integration
- Responsive Range support

US ORS office vision
How to launch very small sats

Quickreach (Air Launch LLC, FALCON program): Air launch concept (internally carried in a C-17 globalstar) ... in development

Performance: 400 kg LEO

Scorpius (Microcosm) “very low cost” LV (modular and simple conception using advanced technologies)

Performance: 250 kg LEO (Sprite)

Numerous projects more or less ambitious... many airborne ideas.

US launchers projects
Existing or future projects of launchers

How to launch very small sats

Russia

Numerous converted Missiles (SS18), operational: Dnepr, Rokot, Volna, Shtil ...

Asia, Israël, ..

Japan: M5, Epsilon 2013 ?, 1300 kg LEO

Korea, Israel: several airborne concepts in project

China: projects in development?

Several airborne projects (Air launch with Antonov, Ishim under Mig-31, etc.)
No known development

India

PSLV Core Alone
1 100 kg to SSO

April 2008 flight with 10 satellites

Numerous converted Missiles (SS18), operational: Dnepr, Rokot, Volna, Shtil ...

Several airborne projects (Air launch with Antonov, Ishim under Mig-31, etc.)
No known development
Gain on the initial mass of an airborne launcher compared to a classical ground take off (objective 300 kg in SSO)
Zoom on MLA concept

- ALD – demonstrator
  Performance ~ 0

- 4p0.3-P2-C0.6
  MLA « compact »
  Performance ~ 20-50 kg

- 2P3.8-P2-C0.6
  MLA « Trimaran »
  Performance ~ 150 kg

- P9-P2-C0.6
  Horus / Falcon*
  Performance ~ 100-150 kg

- H12-P2-C0.6
  Flex (1st stg reusable)
  Performance ~ 100 kg
recent multiplication of micro satellite platforms
increasing success of the associated applications

- Numerous successful technology experiences based on microsats, for Science or Defense with gradual increase in instrument performance
- Constant improvement of quality / price ratio
- Rebirth of interest for constellations (Rapid eyes, Orbcomm2, numerous project worldwide…) and formation flying,
- Increasing number of operational applications accessible : communications, intelligence gathering, early warning, space surveillance, different type of observation, etc.,
- Evidence of the vulnerability of the big space systems,
- Increasing interest for the « Responsive Space » approach in the USA and other countries (China, etc.), which prefer small size in order to reduce global costs et delays, and facilitate the implementation of new technologies

Resolution of small observation satellites launched (1996-2006) and to be launched (2007-2009) by mass

Resolution au sol (m)

Satellite masses (kg)

1996-2006
2007-2009

Satellite masses (kg)

Ground resolution (m)

Svea
Cartosat-2
Pleiades
Razaksat (MACSAT)
Worldview 1 & 2
GEOeye-1

Euroconsult for CNES/DLA – Prospective study of world market for small LEO satellites
Mini / Micro sats (10-500 kg)

World Market

# satellites

46% accessible to European services
First observations

Offer for access to space for small satellites exists worldwide (Space-X Falcon-1, Pegasus, Taurus, Minotaur, Dnepr, Rockot, Volna, Shtill, PSLV and others … ), with known pros and cons.

Solutions exist in Europe too (Vega, Soyuz via ASAP), less flexible but more economic.

The small satellites market is growing year after year but it remains small and uncertain in Europe:
if the accessible market is 10-12 / year, the probable part for a dedicated European LV is less than 50% (3-4 for <200 kg 1-2 for < 400 kg)

⇒ Insufficient justification to develop a dedicated system

Projects for small launchers exist, but no real development has started.
Market Study

Analysis of the present situation:

- Micro-satellites have lower cost, but still lower performance, though increasing
- Difficulties for launching: operations, orbit, delay, cost, ...

For launchers:
- Not enough governmental interest, at least in Europe
- Severe “low-cost” countries competition for new developments lead to
- Not enough industrial interest in Europe

Not enough added value
- No small launcher development
- No micro-satellite market development

Economical situation in the world shall probably take years to improve
What could create a new impulse?

=> Potential new capacities exist with new system concepts
   GEO / constellation – GEO / UAV communication
   split of functions in between GEO, micro-sat, ground
   highly elliptical orbits possibilities

   ....

=> For new services which would take advantage of the specificities
   of small satellites

=> In which the need for launch may be different from the existing offer

are micro-satellites only a smaller replica of bigger satellites?

small satellites are an enabling technology for future space systems

=> Need of a long term strategy
Computer analogy with Space?
Conclusions

• Existing launch capacities for small satellites are globally not satisfactory

• The reproduction of the existing bigger satellites at smaller scale is not enough for developing a new adapted launcher service: many small launchers have been studied, no development has really started

• Break-through innovation could be brought by thinking the whole space system in which the micro-satellite becomes an enabling technology for new societal services, together with GEO / ground systems => long term strategy to prepare

• Re-thinking the global space system includes re-defining also the launcher functions. These two separate worlds can communicate better