SmallSats mission opportunities for the Vega launch system: the Small Spacecraft Mission Service

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1. SmallSat market forecast
2. International competition
3. Understanding needs and constraints
4. Vega launch system
5. Tailoring Vega operational capability
6. SSMS Objectives
7. SSMS Ground Rules
8. VEGA “bus service” to space
9. SSMS implementation cornerstones
Major consulting Offices agree on clear SmallSat market increase next 5 years: 2017 - 2022 (short term)

In particular MiniSats class 100-350 Kg will see a steep increase due to the entry on market of Constellations and Mega Constellations currently in development

Recent study updates (ESA-2016) suggest trend will be maintained also at medium term (2022 – 2027)
Microsats in the range of up to 100 Kg will cover almost 30% of the SmallSats market.

Up to 350 Kg mass, SmallSats will dominate LEO launch requests in number.
A large majority of SmallSat business will come from US in the next 5-10 years.

Therefore, initiatives devoted to implement this launch service shall take this element into account.

US launch prices will be the benchmark for SmallSat launch business.
New launch systems in development or in initial exploitation

• NASA Awards Venture Class Launch Service (VCLS) contracts to provide SmallSat access to LEO. Three selected companies:

➢ **FIREFLY SPACE SYSTEM**

 ➢ **Alpha Launcher Vehicle, two liquid stages (Q1/2018)**
  • Launch rate: 12 - 52 launches/year
  • Commercial Offering: 400 Kg @ 500 Km SSO ($9M)
  • Status: LOX/Ke Aerospike engine (1\textsuperscript{st} stage) test fired.

➢ **VIRGIN GALACTIC**

 ➢ **LAUNCHER ONE, two liquid stages (Q4/2017)**
  • Released by a dedicated reusable carrier aircraft 747 “COSMIC GIRL” at \(\approx 11,000\)m. Two liquid stages complete the spacecraft(s) delivery to desired orbit and then deorbited.
    • Launch rate: 12 - 52 launches/year
    • Commercial Offering: 300 Kg @ 500km SSO ($10M)
    • Status: 747 COSMIC GIRL customisation to be a “Flying launch site” ongoing.

➢ **ROCKET LAB**

 ➢ **Electron, two liquid stages (Q1/2017 - VCLS in July 2017)**
  • Launch rate: 52 launches/year
  • 150Kg @ 500km SSO ($4.9M) - 1U Cubesat from $50k; 3U Cubesat from $180k
  • Status: Second stage qualification tests completed; First stage qualification tests ongoing; Campaign of three test flights.
New launch systems in development or in initial exploitation

- **CASC (China)** >> **LONG MARCH**
  - Long March 6, 3 liquid stages (19 Sept 2015) - N.20 SmallSats released in SSO
  - Long March 11, 3 solid stages + 1 liquid stage (25 Sept 2015) – N.4 Micro Satellites released in SSO
  - Prices of Long March program not available

- **SPACEFLIGHT** >> *Falcon 9 “2017 Sun Synch Express” Mission*
  - Dedicated Rideshare mission: Spaceflight aggregate of SmallSats to be delivered in SSO
  - (5kg 3U CubeSats << >> 575 kg).
  - Falcon 9 Launch price $62M*
  - 3U CubeSat ≈ $250K, 50kg SmallSat ≈ $2M, 150kg SmallSat ≈ $5M

*Official Falcon 9 launcher price (SpaceX web site)*
Understanding SmallSat Customer Needs

- **GUARANTEED AND TIMELY ACCESS TO SPACE**
  
  not feasible with Piggy Back concepts

- **AFFORDABLE LAUNCH PRICE STANDARDS**
  
  to tailor current launch preparation processes

- **DIVERSITY OF REQS**
  
  commercial vs. Institutional/Education stds
Anticipating SmallSat ride-share missions constraints

➢ **SPACE DEBRIS LIMITATIONS**
  
  most SmallSats have no on-board propulsion
  
  orbit altitude constrains

➢ **SHORT AND LONG TERM COLLISION RISKS**
  
  Short term: complex separation sequence
  
  Long term: limits on # of SCs separations on same orbit
  and orbit selection constraints

  >> versatile upper stage, limited # of SCs in aggregate
Launch systems operational capability

Launch systems

- **HEAVY LIFTERS** >> high energy availability, lower Euro/Kg, ride share with high # of SCs but complex aggregate and mission preparation, low flexibility

- **MICRO LAUNCHERS** >> new concept, launch cost namely attractive provided prod. rate high, none currently available, several initiatives on going

- **SMALL LAUNCHERS** >> existing concepts suited for majority of SmallSats orbital reqs (LEO), compromise between two above cases, *need limited # of SC in the aggregate to reach positive business case*

Operational tailoring to SmallSats

- Independent from launch system choice, **OPERATIONAL TAILORING** is key to enable launch of **SMALLSAT MISSIONS**

- Not all launchers worldwide can ensure both guaranteed and timely access to space at affordable prices since not operationally tailored to perform dedicated SmallSat missions

**Innovation on mission service is a primary enabling element for SmallSat launches**
Small Spacecraft Mission Service

Vega Launch system – VERTA flights

Flexibility demonstration flights to secure the competitiveness of the Vega launcher through a smooth learning approach

• one robust and stable configuration of the launch vehicle dimensioned for a wide range of missions;
• implementation of the multi-payload configuration;
• flight data and testing experiences to improve reliability, refine margins, strengthen technology.

Qualification status of the launch System certified at Post VERTA FQR

• Qualified perimeter and relevant justifications
• Reserves to Qualification, Limitations of Use
• Functional files updated based on Flight data
• Mathematical models and simulators calibrated
• Complete set of guidelines as outcomes from the qualification process to guarantee the operability of the Launch System (definition of boundaries and requirements)
Vega C Launch system

Objectives:
• Consolidating the VEGA position against competitors in terms of performance to capture market up to radar satellite (i.e. > 800 kg with respect to the current version at the same reference orbit, 700 km PEO), without increasing exploitation costs;
• Reducing the VEGA dependency on non-European sources by introducing European equipment and components, without increasing exploitation costs.

Status:
• VEGA-C Launch System RKP(SRR) – Completed on 12/2015
• VEGA-C Launcher System PDR – Completed on 03/2016
• VEGA-C+ Launcher System CKP – Completed on 04/2016
• VEGA-C+ Launcher System Delta-PDR – Planned on 10/2016
• VEGA-C+ Launch Base GPM PDR – Planned on 10/2016
• VEGA-C+ Launch System SDR(PDR) – Planned on 12/2016
• VEGA-C+ Launch System Phase-C/D Start – Planned on 01/2017

Short Term Priorities:
• Completing the industrial negotiations for VEGA-C+ by 10/2016
The Vega and Vega C Launch systems

Configuration:

VEGA

- New Fairing
- New Avionics
- AVUM+
- New I-S/2-3
- New Z40
- New I-S/1-2
- New P120C
- New I-S/0-1

VEGA-C

- BERTA Engine // Design (not in VEGA-C baseline)
- P120C
- 400 T Thrust
- 142 T Solid Propellant

ARIANE-6
Objective

- **TO DEVELOP A TAILORED MISSION SERVICE OPERATIONAL CAPABILITY WITH THE VEGA SYSTEM**
- **SUITEC TO GUARANTEE ACCESS TO SPACE TO SMALLSAT USERS AND OWNERS**
- **TO THIS END, IN COLLABORATION WITH ARIANESPACE, DEFINE AND MAINTAIN A COMPETITIVE BUSINESS CASE**
Ground rules: on going work

- **Standardisation of SmallSat requirements**, in collaboration with main Players (i.e.: Customers and Operators)
- Development of *standardised and modular launcher elements* dedicated to SmallSat missions to minimise missioning needs
- **Innovation on missioning and launch preparation technologies and processes**
- Adoption of *marketing and commercial policy* adapted to SmallSat business case, linked tight with *DTC approach* to development and industrial activities

*Continuous up-to-date business case studies all along development of mission service will enable realistic SmallSat launches*
VEGA Bus Service to Space

- To define pre-planned launch dates according to launch rate capability and Arianespace exploitation manifest
- To issue AOs accordingly
- To allocate well in advance to launch date, optimised PL aggregates to each launch
- To define advanced overbooking and replacement logic to mitigate risks of SC withdrawals or delays
- To define a tailored launch price list based not only on SC mass/dimensions but also on requested services
- To enable Missions Service modularity to cover both FLEXI (Rideshare) and PIGGY BACK missions according to Arianespace needs, to develop Dispenser modularity accordingly
- To enable ride share launch of at least 15 SmallSats on Vega, increased on VegaC
**Vega SSMS BUS service to Space**

1 year

Launch 1

- 4 Minisats - 80-150 kg
- 800x800 h1000 mm
- @ 640 km SSO

- 6 Microsats - 40-60 kg
- 600x600 h600 mm
- @ 500 km NON-SSO

Launch 2

- 1 Minisat - 200-300 kg
- 1500x1500 h2000 mm
- @ 800 km SSO

- 3 Microsats - 60-80 kg
- 600x600 h1000 mm
- @ 640 km SSO

- 6 Microsats - 40-60 kg
- 600x600 h600 mm
- @ 500 km NON-SSO

Launch 3

- 4 Minisats - 80-150 kg
- 800x800 h1000 mm
- @ 640 km SSO

- 6 Microsats - 40-60 kg
- 600x600 h600 mm
- @ 500 km NON-SSO

**Spacecraft 40kg**
Lateral separation

**Spacecraft 60kg**
Lateral or vertical separation

**Spacecraft 150kg**
Vertical separation

**Spacecraft 300kg**
Vertical separation
SSMS Implementation cornerstones

- **PROGRAMMATICICS**: modular system to support FLEXI (rideshare), Constellation and Piggy Back missions
- **HW**: low cost dispenser with COTS HW and technologies, maximise use of launcher existing features
- **Process**: SCs accommodation and Missioning tailored to SmallSats, AGGREGATE optimised accordingly
- **Process**: SCs Launch Preparation and AIT standardised, EU tasks maximised
THANKS FOR YOUR ATTENTION

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