MICRO-SATELLITES ADVANTAGES. PROFITABILITY AND RETURN

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Abstract: To the assessment of satellite’s capabilities during their progress can be added indices as mass, size and cost. At the final stages of their life-cycle development, owing to the progress in current space technologies, the idea for using small satellites is approved. The small satellites are specified as work-efficient, productive and promising. The estimation and the choice ensue from economic preferences for efficiency, finance return and positive results. Economically effective and profitable satellites are created looking for economical benefits in short time.
The main aim of this paper is to examine the major advantages of micro-satellites, valuation of their capabilities, including economic categories as efficiency and return.

Space equipment very distinctly manifests its unique, compared to other analogous resources, possibilities to spread information to any point on Earth. Some aspects of human activity like transport, navigation, intercommunications and communications, meteorology and others are impossible to exist without the information provided by satellites.

In 1957, the Soviet Union launched the first artificial satellite, Sputnik I. It weighed a little over 80 kilograms. Ever since, satellites have grown heavier, larger and more complicated, and most now tend to weigh in at three to four tons. But with each kilogram costing about $10,000 to put into orbit, it is somewhat curious that satellites have not shrunk in size, weight and price, as have so many other high-tech products.

Current trends in space research and development agencies and industries gradually place greater emphasis on reducing the costs for the development and operations of the satellites in orbit. According to a survey, 60% of spacecraft costs were primarily derived from the satellite operations. In order to decrease mission costs, it has become necessary to reduce operational costs, especially starting with the education and training of aerospace-majored students in the universities and colleges.

Through technical minimization, micro-satellites are currently of increasing interest. Their possibilities as well as their scope of missions is growing steadily. Today, payloads with a mass of just a few kilograms are able to perform measurements that would have been unthinkable a few years ago. The major advantage is the fast and cheap development of micro-satellites, which makes them a suitable platform for technology evaluation. Hence, they provide the ideal opportunity to test new systems in space within a short timeframe and low budget.

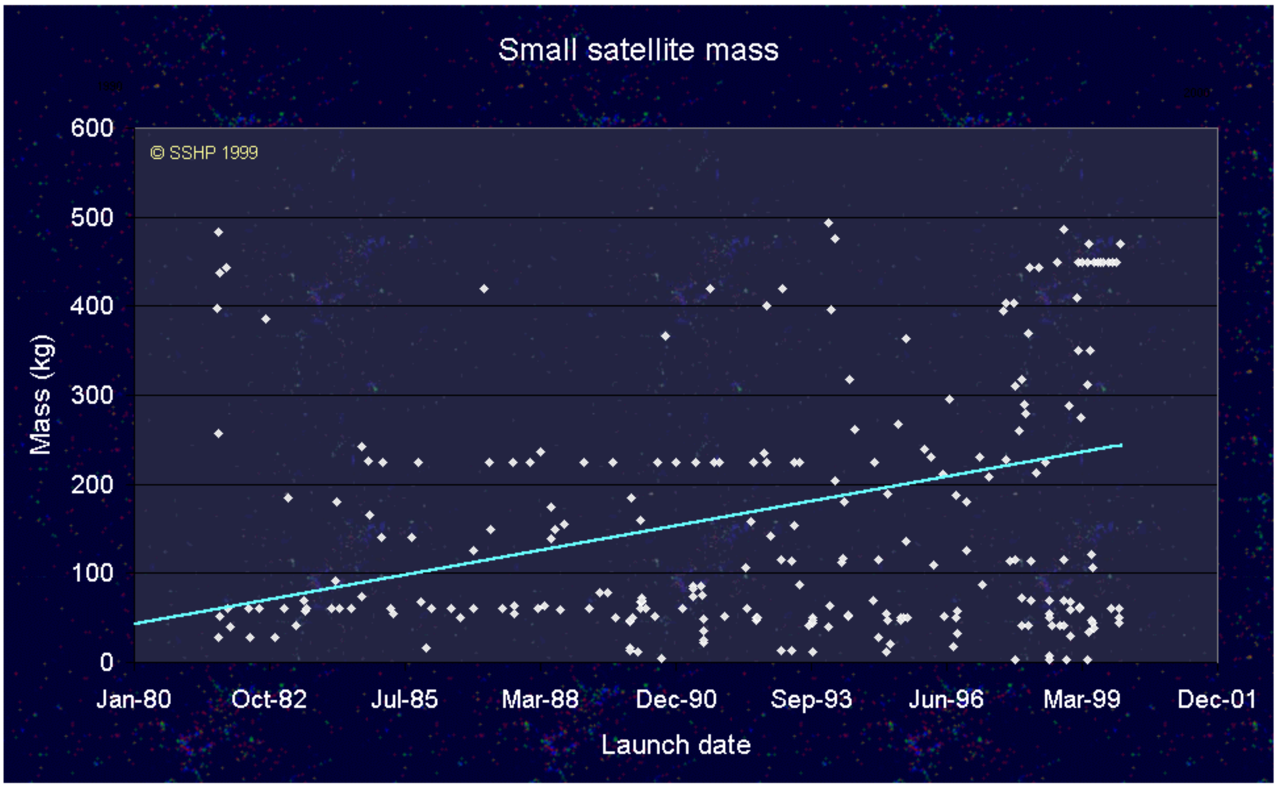

Fig. 1 Small satellite mass

Today, a satellite is considered small if it weighs less than 500 kilograms, although many of the more innovative and functional small satellites weigh less than 100kg. Cost, of course, has been the main attraction of small satellites, as launchers needed to hoist them into orbit account for at least 30-40% of total expenses. Every kilogram saved in the payload's weight means a kilogram less thrust needed from the booster. That translates into a double saving in fuel that has to be hauled along for the ride as well as in the airframe of the launch vehicle itself. The structural cost of an unmanned spacecraft runs to around $5,000 per kilogram. After launch costs, insurance is the second largest expense in getting a satellite into orbit, accounting for as much as 15-20% of a mission's price tag. The cost of using conventional satellites (>$100M each) to implement a network of Earth observation satellites tailored specifically to disaster prediction, detection, monitoring and mitigation, has proved prohibitive - as the whole network would cost nearly $1000M to build and launch.

However, recent advances in microelectronics has generated a new species of modern, highly sophisticated, computationally powerful, rapid-response micro-satellites (and mini-satellites) that have reduced the cost of a single satellite by more than an order of magnitude. These "faster, cheaper, better" micro-satellites now make the implementation of such a disaster network both practicable and affordable.

Class	Cost	Mass
Large satellite	$ > 100 M	> 1000 kg
Small satellite	$50 - 100 M	500 - 1000 kg
Mini-satellite	$ 5 - 20 M	100 - 500 kg
Micro-satellite	$ 2 - 3 M	10 - 100 kg
Nano-satellite	$ < 1 M	< 10 kg

Table 1: Classification of Satellites

These modern microsatellites and minisatellites are designed and built within a different philosophy to that used for conventional satellites and offer:

- low cost
- rapid response
- tailored mission & sensors
- high operational flexibility (re-programmable)
- low operational cost (high autonomy)
- direct access (low cost terminals & Internet)
- long operational lifetime in orbit (>10 years)

The use of small satellites for Earth observation has received considerable attention. As the cost of conventional remote sensing missions continues to escalate, smaller and cheaper satellites are becoming increasingly attractive. While many studies have been devoted to implementing small imaging satellites, most of these designs focus on systems with masses of 300 - 600 kg. Relatively little attention has been paid to the possibilities of employing tiny 50 kg microsatellites for remote sensing. Conversely, SSTL's (Surrey satellite Technology Ltd.) activities in Earth imaging are tightly focused towards implementing useful imaging systems within the constraints of very small satellites.

Natural and man-made disasters incur enormous costs every year. Effective and timely monitoring from space is an urgent national requirement in order to be able to react quickly to mitigate the effects of different disasters. Networks of Earth observation satellites have been proposed in order to improve upon the coverage and revisit time of existing systems, however the very high cost of conventional remote sensing satellites.

Remote sensing microsatellites are very attractive because of their low cost and fast development schedules, in particular because they make independent or dedicated, as opposed to general-purpose, imaging missions affordable. However, these very small spacecraft present many constraints to the design of imaging payloads that are not experienced on conventional large satellites.

Microsatellites have a high mobility due to their compactness and small mass which is essential for observing the following category of events: weather phenomena like hurricanes, lightning or polar lights, spectacular fires, volcano eruptions, floods, earth quakes, ship, plane or railway accidents or any other events of this type which e.g. a news agency would like to present in the news. This interesting area is typically only a few square kilometers large and the resolution requirement is of course as high as possible.

The key limitations for an imaging system on a microsatellite can be summarized as:

- Payload mass under 12 kg
- Payload volume no more than 30 cm cube
- Continuous payload power under 5 Watts, peak power up to 15 Watts

- Preferably no moving mechanics
- Attitude control to within 2
- Reduced communications data rates (9.6 / 38.4 kbps)

hese are very tough limitations, incompatible with the requirements of many conventional imaging systems. Most current imaging systems use scanning to capture the scene line-by-line as the satellite passes over the Earth's surface, using either the 'whiskbroom' scanning technique (favored in US designs, with mechanically-active oscillating mirrors) or the 'push broom' technique (which uses a linear charge-coupled device, used on European and Japanese satellites). However, because it takes tens of seconds to build a complete picture, the satellite's stability cannot be allowed to drift, or else the image geometry will be distorted. This places very great demands on the platform's attitude determination and control system, which cannot be achieved using current microsatellite technology. Furthermore, 'whiskbroom' scanning imagers are too massive and power hungry to be supported on a microsatellite.

A lthough the above-mentioned technical details impose limitations to the usage of microsatellites for image recording, they are competitive enough due to their advantages as modern, low-cost, rapid-response, highly reliable, long-life-time space systems.

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TSE – States and Organization (http://www.tbs-satellite.com/tse/online/thema_origine.html)

Государственное конструкторско бюро “Южное” (http://www.yuzhnoye.com/index.htm)