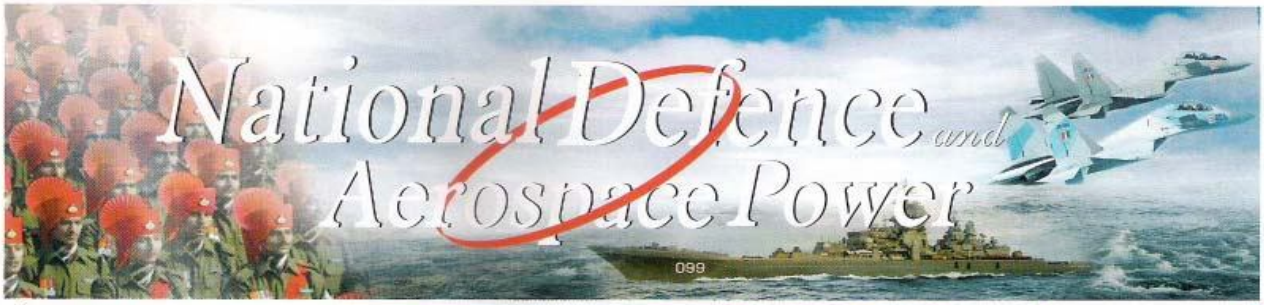

Centre for Air Power Studies ISSUE BRIEF

108 / 15 **27 October 2015**

Space Security and Small Satellites: The Critical Need for International Law to Regulate Issues in Outer Space

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The Small Satellite Surge

The era of small satellites is back. They are cheap, expendable and practical in many more ways than one. They were a practical option ever since the Former Soviet Union introduced small satellites in the 1960s for environmental data collection, scientific testing communication data relay etc. However, towards the 1980s as the utility and variety of payloads on satellites increased and launch capabilities got better, medium and large satellites became more popular.[1] With modern technologies and increasing miniaturisation, numerous options unfold and small satellites are again becoming an attractive option for both military and civil applications.

During 2000-2012, the numbers of small satellites launched were in the range of 20-25, the figures shot up to 92 satellites (launched) in 2013, and the next year, it went even higher at 158 and the pace continues in 2015.

The figures are indicative; from the years 2000-2012, the number of small satellites launched were in the range of 20 - 25, the figures shot up to 92 satellites launched in 2013, and the next year, it went even higher at 158 and the pace continues in 2015.[2] The corresponding number of satellites and consequently orbital crowding also rises; for instance in 2004, only 76 satellites were launched of which 07 were small satellites. By 2013, with 158 small satellites the total number of satellites launched was 215. The point being made is the era of small satellites is back and is likely to stay. There exists no significant indicator that points to the contrary. Across the globe, more and more agencies (national, multinational and private) are putting small satellites into orbit with no clear regulation in place.

The word small satellites is suggestive of its size and role and yet to be on a common grid, it would be essential to briefly examine the terms as they are known in common parlance and the same is undertaken in the Table 1.

The Good News

While the initial utility of small satellites was largely confined to environmental observation, scientific tests and communication relay, the utility today is more varied, multifaceted and complex. They can be put to a variety of civilian uses like Earth observation (IMS-1), disaster monitoring (DMS), education (Annasat, Ardusat), astronomy (Brite-PL) as also military applications like the SENSE-1 of the US Air Force etc. These are low-mass and low-cost platforms that can be sent into orbit for much less than a few million dollars and are an attractive option for space faring as also non-space faring nations,

corporations, educational institutions as also individuals. Unlike a medium or large satellite that is difficult to make and even more difficult to launch, small satellites provide an easier and affordable alternative. Since they are small, they are easier to launch and one is now witness to hitherto unheard missions like a single launch by Orbital Sciences that put a record 29 satellites into Low Earth Orbit in November 2013. Thirty hours later, *Kosmotras*, a Russian joint-venture, carried 32 satellites into a similar orbit. Then, in January 2014, Orbital Sciences carried 33 satellites up to the International Space Station (ISS), where they were cast off a month later. A similar logistic resupply mission to the ISS was by Space-X that envisaged placing in orbit 104 'Sprites', not much larger than postage stamps that contain all the basic elements of a satellite like radio, solar cells, aerials and other instruments. However, due to a fault the mother ship failed to deploy and they burnt on re-entry. The above notwithstanding, across the world, a variety of small satellite projects are on the anvil. Put briefly, as the mass is small, launch is easier and as the uses and users of space rise, one can only expect the proliferation of microsatellites to rise exponentially and herein lie the dangers of unregulated growth and expansion.

Table 1

CLASSIFICATION OF SMALL SATELLITES BY MASS		
Satellite Class	**Mass Range**	**Functionality**
Femtosatellite	10-100 Grams	In Swarms
Picosatellite	100-1000 Grams/1 Kg	In Swarms
Nanosatellite	1-10 Kg	Individually and in Groups
Microsatellite	10-100 Kg	Individually and in Groups
Small satellite	100 – 500 Kg	Individually and in Groups

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The Impact of the Lack of Laws Regulating Small Satellites

On the brighter side, the democratisation of space capabilities is good and desirable; however, the manner of the present growth and proliferation of small satellites is unruly at best and fraught with dangers for all of humanity. The rise in swarms of small satellites is astonishingly rapid, unprecedented and unruly as of now. The revolution in small satellites far outstrips the pace of review, reform and regulation possible by the lone regulatory body, the International Telecommunication Union (ITU). The challenges are increasingly manifest with every launch and the archaic Radio Regulations of the ITU are clearly ill-suited to the task. The ITU has played a significant part in regulating radio frequencies since 1959. However, it needs to be borne in mind that satellite transmissions are only one of the many kinds of international communications regulated by the ITU. As a matter of fact, ITU treats space radio as just another aspect of the general regulations on use of the radio spectrum that finds its place in the overall definition of telecommunication as "Any transmission, emission or reception of signs, signals, writings, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems."[3]

Small Satellites and Space Security

It is critical that the issue be given its due. Radio regulations in outer space are nothing more than one of the instances that constitute a grey area. A variety of other issues abound; there exists no definition of a small satellite, the registration issue with respect to swarms of multi-agency satellites are vague, spectrum, frequency and slot allocation issues are a potential nightmare. Apart from the above, increasing number of satellites translates into overcrowding in useful orbits and ominously increased debris. The amount of junk orbiting in outer space certainly inspires very little confidence in any manner of environmental damage mitigation or sustainable development in outer space. The orbital debris hazards of the potential swarms of satellites once they have outlived their utility are manifold and yet to be comprehensively understood for environmental mitigation to be put in place.

The impact on national security concerns though not immediately manifest would soon become apparent. A variety of Anti-Satellite roles can be envisaged with the right kind of equipment in place. There exists no verification mechanism as of date and the potential for interference; intentional or unintentional, harmful or otherwise is immense. Equally immense is the possibility of suspicious manoeuvres by satellites (perceived suspicious or otherwise) snowballing into bitter acrimony. On the one hand, manoeuvring small satellites could be used for on-orbit inspection, repair etc and they could also be used to collide into other satellites or even carry lasers or other directed energy weaponry to burn satellite optics etc. The possibilities and scenarios are manifold. With no semblance of global space traffic management in place, one can expect mutual suspicions and rivalry to snow-ball into actual conflict in space. For instance, the sheer number, flexibility of roles and lack of homogeneity in the small satellites as also the challenges of tracking small satellites would ensure that it is nearly impossible to apportion blame in case of an accident or incident in space or for that matter even collision amongst space objects. Tracking objects in outer space is a task by itself. Apart from the US, no other nation has credible capabilities for Space Situational Awareness and the US has its own limitations in tracking objects less than a meter in cross-section. To the obvious question that who on – earth would have control, or even be able to observe a Femto-satellite or smaller satellite that has spiralled out of control, the answer would be nobody. The magnitude of the problem is enormous and unless steps are taken today to regulate the plethora of problems likely with the profusion of small satellites in usable earth orbits, all of humanity tomorrow might lose access to space.

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The Indian Context

With regards to India, small satellites present opportunities and challenges in equal measure. On one hand, student endeavours like Annamalai University's 50 kg microsatellite called Anusat as also IIT Kanpur's 4 kg nano-satellite Jugnu and numerous other university endeavours do serve to ignite young minds and encourage. However, with increasing miniaturisation, nanotechnologies, and a surfeit of related technologies the use of microsatellites has become much more multifaceted and purposeful. The payloads in case of Indian satellites continue to be conventional, size and real-estate issues on Indian satellites continue to be a formidable challenge.The microsatellite revolution is yet to impinge India in a credible manner, if one is to go by the trend of standard satellite and payload sizes typical to Indian products. On the other hand, with launch technologies, particularly cryogenic and propulsion technologies maturing, it is time miniaturisation gets a fillip in the Indian context to ensure optimal utilisation of launch capabilities. It is time microsatellite payloads went beyond student endeavours onto more serious issues of earth observation, communications and scientific research.

The challenges posed by the proliferation of small satellites are manifold and the situation affects India as well. On the one hand, small satellite launches by India for nations across the world do enable short term profit. But, the question is how long would it be before market saturation takes place. Once the initial surge is over, the market is likely to stabilise and India would need to prepare itself for lower profit margins once the swarms are in place. One may still contend that economic factors are complex, unpredictable and hence it is too early to look at the shifting patterns. Consequently, no great threat to the national space economy may be envisaged.

Nothing stops sensitive imagery and signals intelligence from proliferating to interests inimical to India...the possibility of space capabilities proliferating to terrorists is no longer remote.

However, if one goes beyond the economic factors and takes into account the factors on national insecurity presented by small satellite proliferation, an ominous picture unfolds. For instance, the possibility of space capabilities proliferating to our adversaries is no longer remote. Capabilities can now be bought cheap off the shelf from a number of agencies. An unregulated market indicates little or no accountability. At present, nothing stops sensitive Imagery Intelligence (IMINT) and Signal Intelligence (SIGINT) from proliferating to interests inimical to India. The possibility of a small satellite Low Earth Orbit communication constellation being procured for communications and coordination is no longer far-fetched. Small satellites enable a variety of other capabilities that cause damage and destruction to national assets so much easier, cheaper, accessible and effective. The possibility of space capabilities proliferating to terrorist groups is also no longer remote. Having borne the brunt of numerous insurgencies and conflicts ever since independence, it is essential that India pre-empts the situation and takes action accordingly. After-all, everyone agrees that precaution is better than cure.

Notes:

[1] For a historical perspective, see Siegfried W Janson, "25 Years of Small Satellites" , 25th Annual AIAA/USU Conference on Small Satellites at http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1117&context=smallsat, accessed on 24 October 2015.

[2] For details on figures, see Space Works, "Nano/Microsatellite Market Assessment" at www.sei.aero/.../SpaceWorks_Nano_Microsatellite_Market_Assessment, accessed on 24 October 2015.

[3] Ref Constitution of International Telecommunication Union, Article-37.

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