Satellites – going bigger or smaller? Yes

On September 6th, the GeoEye-1 was launched out of California's Vandenberg Air Force Base… only a week earlier, the RapidEye constellation of five satellites blasted off… Each of the RapidEye sats is less than a tenth of the size (by mass) of the GeoEye system.

Go big or go small? Rarely have we had such an opportunity to witness the contrast in evolution of the size and scale of satellite systems in such a short time span. Nearly a month ago, and coincidentally merely a week apart from each other, saw the launch of two new ways to see the world and, indeed, two ways to see the future of satellites. On September 6th, a powerful new geospatial imaging system, the GeoEye-1, was launched out of California's Vandenberg Air Force Base. It had good company to join. Only a week earlier, on August 29th, the RapidEye constellation of five satellites blasted off from Baikonur, Kazakhstan to form the newest entry into the commercial multispectral remote sensing market. Contrasts were striking indeed. Each of the RapidEye sats is less than a tenth of the size (by mass) of the GeoEye system – only 150 kg each. As in the electronics industry, is smaller the future?

It is always a pleasure to see a successful launch of new space-based services, and we offer our congratulations to all players involved. One particularly proud player in all of this should be Surrey Satellite Technology Limited (SSTL), the UK-based organization that built the highly compact buses for the RapidEye constellation. Having grown out of a university project in the early 80s, SSTL has been a force in the development of small satellites for the last two decades, pushing the limits in satellite size and capability in dozens of systems. Along the way they have been joined by many fellow travelers – enthusiasm for building satellites as small as a single kilo has exploded among academic institutions, scientific missions and even in military circles. A small satellite can now be built for as low as a few million dollars apiece – compare that to the standard quarter-billion dollar telecom sat. The idea of building low-cost satellite systems assembled on rapid schedules appears to be an economically attractive one.

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On the other hand, commercial space systems have been less likely to trend towards smaller and, in fact, have been going distinctly the other way. Commercial telecom satellites have been growing ever larger, under increased demands for ever larger and more powerful antennas, more transponders and spot beams and more power from larger arrays of solar panels. Telecom satellites routinely weigh in at over 5 metric tons and some now weigh over 6 metric tons. Soon-to-be-launched mobile services satellite

Terrestar-1, with a record 20 meter deployable antenna, will weigh in at about 6700 kg – more than almost any other commercial satellite ever launched. If there is an economic argument for going small, the commercial market has other ideas.

The argument can go the other way… trade resolution for faster revisit times and greater coverage… positioning for more dynamic demand.

Some of this is the inevitable result of engineering requirements emanating from market demand. Telecom satellites are getting bigger because consumers demand smaller handsets and more bandwidth. Physical constraints demand that nothing less than bigger satellites to satisfy that requirement. Remote sensing sats, like GeoEye-1, are also getting bigger because higher resolutions demand larger aperture sizes.

The argument can go the other way. RapidEye, for instance, trades resolution for faster revisit times and greater coverage, positioning itself for more dynamic demand, such as for weather events, natural disasters and seasonal land use surveying. Another small satellite system, Orbcomm, focuses exclusively on low data-rate machine to machine communication – a market that argues for the low capital cost of deploying small satellites.

How do small and large satellite systems measure up economically for their sponsoring businesses? So far, direct comparisons between small satellites and their larger brethren are hard to come by in direct commercial markets. The chart below compares the most recent example. Both the RapidEye constellation and GeoEye-1 had roughly equivalent costs, with both having a degree of government participation. Are the five sats of RapidEye the rough equivalent of one GeoEye-1? The market will tell the story.

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	RapidEye	GeoEye
Size	5 satellites	1 satellite
Mass per sat	150 kg	1955 kg
System costs	€160 million	$209 million

A possible comparison would be the various competing mobile satellite systems deployed in the mid-90s. The chart below compares the first generation Orbcomm and Iridium systems with the Inmarsat-3 satellite system, all launched within a few years of each other. Subscribers are based on the most recently available data. Revenues and EBITDA are annualized for 2008 based on most recently available information. Readers should note that

Inmarsat financial numbers reflect the operation of the newer Inmarsat-4 system.

	ORBCOMM	iridium	inmarsat
System	Orbcomm	Iridium	Inmarsat-3
Size	28 satellites	66 satellites	5 satellites
Mass per sat	45kg	689kg	2068kg
System costs	$330 million	Approx. $6 billion	Approx. $1 billion
Subscribers	420,000	305,000	235,400
Revenues (m)	27.2	312.0	623.2
ARPU	$64.76	$1022.95	$2647.41
EBITDA (m)	(2.5)	107.0	435.4

Of the three, Orbcomm was certainly the cheapest to build out, but its limitations to low data rate communications has meant that it must overcome much lower average revenue per user (ARPU) than its competitors. Iridium and Inmarsat were much more expensive systems, yet garner far more revenues on account of their increased capabilities in voice and high data rate communications. They also have positive EBITDA, an indicator of maturing companies. On the other hand, Iridium can boast a model few businesses can – after the original company went bust on low subscriber growth buried under huge capital costs, private investors bought the whole system for $25 million. When you can get that kind of a deal, who needs small satellites?

The biggest thing to watch will be not so much the size of the satellite but the functions that they will serve and the potential for new markets to be opened up.

Where do we go from here? Will new technologies allow small satellite systems to gain the capabilities of larger systems? Will the business case to go smaller be compelling? The biggest thing to watch will be not so much the size of the satellite but the functions that they will serve and the potential for new markets to be opened up. What systems will be used to finally bring mobile satellite communications to regular handsets, or to deliver high-resolution real-time earth imaging around the globe, or to provide robust technology demonstration services? Will they be big or small? Yes.

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