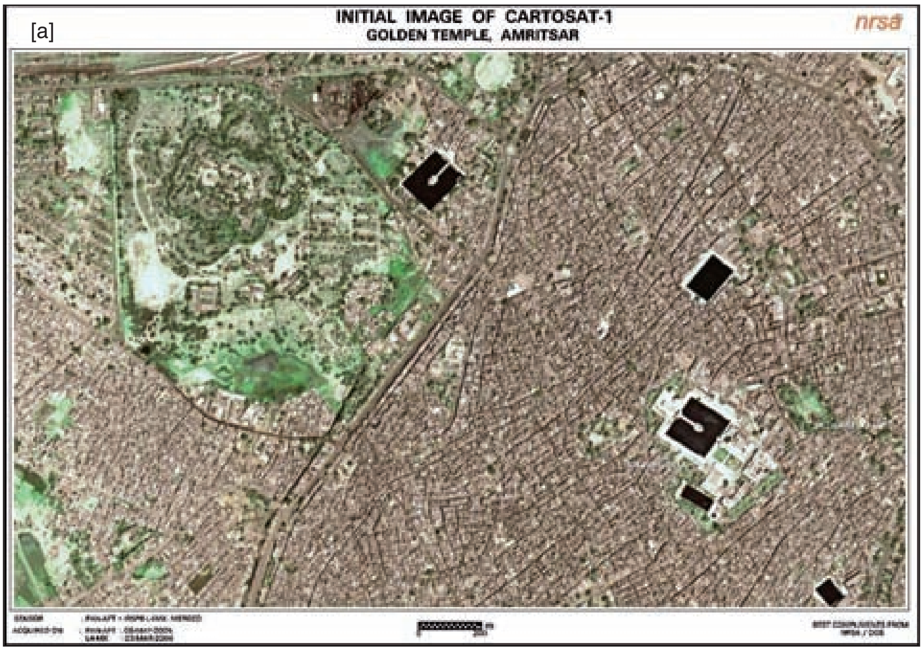
## Developments in South & East Asia

# Space Image Acquisition for Geosp

*By far the biggest source of the data needed for geospatial intelligence purposes comes from the high resolution imagery acquired from spaceborne and airborne platforms. In the specific context of South and East Asia, where there are numerous concerns about national security and threats from neighbours, the primary source for this type of intelligence is spaceborne imagery. Indeed the defence and security agencies in the larger countries in this part of Asia have all been large consumers of the high-resolution space imagery provided. by commercial suppliers such as GeoEye, DigitalGlobe, SPOT Image and ImageSat International. However, recently, nearly all of these Asian countries have either acquired or they are creating their own national capabilities to acquire this type of imagery to overcome the actual or potential restrictions and the delays that occur with the supply of space imagery from sources outwith their control. The situation has already been discussed in a preliminary manner in an article published in GeoInformatics by the present writer three years ago (in the March 2004 issue) as part of his world wide survey of high-resolution imaging from space. This new article will concentrate on the many new developments that have taken place in the region since then.*

By Gordon Petrie



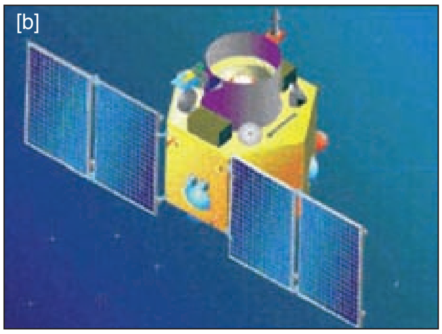




*Fig. 1* ***(a)*** *- A rectified backward-pointing pan image (with 2.5 m GSD) of part of the city of Amritsar in the state of Punjab, India that has been acquired by the Cartosat-1 (IRS-P5) satellite. The pan image has been colourized using multi-spectral image data (with 6m GSD) from the Resourcesat (IRS-P6) satellite. The Golden Temple and its surrounding lake - which is at the centre of the Sikh religion - appears in the lower right part of the image. (Source: NRSA, India)*
***(b)*** *- An artist's impression of the Cartosat-2 high-resolution satellite. (Source: ISRO)*

## India

Twenty years ago, India set out to be a major player in space remote sensing. As part of this endeavour, it developed its own powerful PSLV launch vehicles and a range of imaging satellites. During the latter half of the 1990s, the Indian Space Research Organisation (ISRO) operated its ***IRS-1C*** and ***IRS-1D*** satellites very successfully. These two satellites generated pan imagery with a ground pixel or ground sampled distance (GSD) of 6 m and multi-spectral imagery with 23 m GSD. The follow-on satellite in this series is the ***IRS-P6 Resourcesat***, launched in 2003, which also produces imagery with 6 m and 23 m GSD. However at the higher resolution (6 m GSD), it can produce either pan or multi-spectral imagery, the former having a much greater swath width.

While these IRS images have proven to be useful for earth resources applications, their ground resolution was not adequate for national security and geospatial intelligence purposes. This became very evident during the surprise large-scale attack by insurgents across the Indian/Pakistan border in Kargil, Kashmir in 1999. As a result, the Indian government implemented a crash programme which resulted in the construction and launch of the ***TES*** reconnaissance satellite. By all accounts, this produces pan imagery with a l m GSD. In implementing this programme, it was greatly helped by Israel through the supply of a high-performance optical telescope (from ElOp) and various sophisticated electronics components. Since my previous account in 2004, ISRO has placed two more high-resolution satellites into orbit. The first of these is ***Cartosat-1*** (IRS-P5), launched in May 2005 [Fig. 1 (a)]. This carries twin pushbroom scanners equipped with 12k CCD linear arrays having 7 μm detectors. These two scanners are tilted along track at angles of +26° (forward) and -5° (backward) to generate pan stereo-

# atial Intelligence


*Fig. 2 (a) - ROCSAT-2 (now re-named Formosat-2) being lowered on to its base prior to tests being carried out on it by engineers from Taiwan's National Space Program Organisation (NSPO). The optical telescope of its pushbroom scanner is mounted on top of the main body of the satellite. (Source: NSPO)*
*(b) - The ROCSAT-2 satellite, enclosed in its fairing, is being transported to be mated with the Taurus rocket used to launch it at Vandenberg Air Force Base (AFB) in California. (Source: National Cheng Kung University)*
*(c) - A Formosat-2 pan image (with 2m GSD) of Gibraltar showing the airfield, the harbour and the famous fortified rock. (Source: SPOT Image)*

images simultaneously having a 30 km swath width and a 2.5 m GSD. The satellite can also be tilted in the cross-track direction to cover terrain located to the side of the satellite's ground track. The second satellite is ***Cartosat-2*** [Fig. 1 (b)], which has just been launched successfully on 12th January 2007. This is equipped with a single nadir pointing push-broom scanner producing pan imagery with a GSD of 0.8 m and a swath width of 9.6 km - which may not be too different a specification from that of the TES satellite.

Besides the high-resolution space imagery being generated by its own satellites, India is also a major customer for the imagery acquired by other countries. As part of an official agreement with Israel for cooperation on space imaging projects, the Indian ground receiving station at Shadnagar has been acquiring high-resolution imagery from the commercial EROS satellites. Suggestions have also been made both in the Israeli and Indian press that further imagery has been downloaded from Israel's Ofeq-5 military reconnaissance satellite. Besides which, the Indian national newspaper, 'The Hindu', reported that Indian organisations, mainly defence agencies, have been buying 20 million rupees ($450,000) of IKONOS imagery per year from the Space Imaging company. Still more imagery from QuickBird has been purchased from Digital Globe. As an aside, it is interesting to note that, in May 2005, Space Imaging - which had been selling India's IRS-1C, IRS-1D and IRS-P6 imagery world-wide (outside India) since 1995 - announced that it had acquired similar rights from the Antrix Corporation (the commercial division of ISRO) to sell Cartosat-1 imagery. However, with the take-over of Space Imaging and its merger with ORBIMAGE to form GeoEye, the agreement lapsed. Antrix then re-negotiated the previous agreement with GeoEye in respect of the Resourcesat (IRS-P6) imagery. However Antrix decided not to renew the agreement in respect of the high-resolution Cartosat imagery. Since the agreement gave Antrix access to Space Imaging's world-wide network of ground stations and sales outlets, it would be interesting to know the real motives - commercial, security or whatever - behind this decision not to re-negotiate the agreement in respect of the Cartosat imagery.

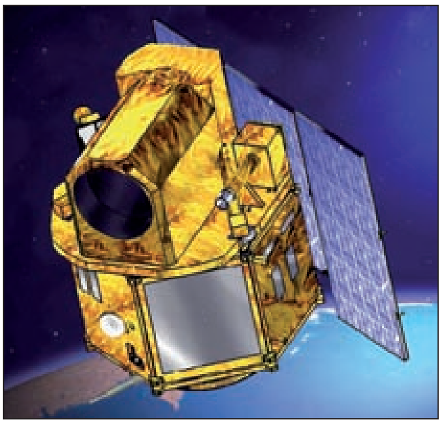


*Fig. 3 - An artist's impression of the THEOS satellite being operated in space. (Source: EADS Astrium)*

Which then brings up next the matter as to what use India is making of this large volume of high-resolution space imagery that it is acquiring. As frequent papers given at international conferences and numerous articles published in the trade press make clear, India is highly restrictive about supplying any kind of high-resolution geospatial data - whether maps or imagery - of its own territory to any foreign customers and even to its own nationals. Indeed such is the level of security that the matter of how the imagery is being used for geospatial intelligence purposes by Indian agencies can only be a speculation. In the case of the Cartosat-1 stereo-data, the DEMs that can be extracted will be of great utility both to military planners and for use in operational aircraft, cruise missiles (developed in cooperation with Russia) and UAVs (bought fr-



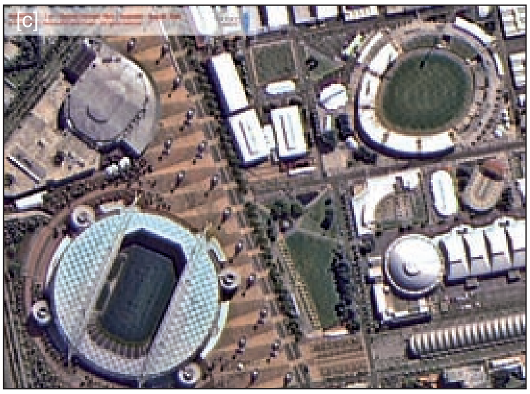



*Fig. 4* ***(a)*** *- The KOMPSAT-2 satellite operating in space - as depicted by an artist. (Source: KARI)*
***(b)*** *- A KOMPSAT-2 pan image (with 1m GSD) of part of the San Francisco International Airport with several wide-bodied aircraft attached to the terminal building by telescopic bridges. (Source: SPOT Image)*
***(c)*** *- A coloured multi-spectral image of part of Olympic Park in Sydney, Australia showing the stadiums and other facilities built for the 2000 Olympic Games. (Source: SPOT Image)*

om Israel!). Besides which, they will have a direct application to topographic mapping by the Survey of India, which, although it forms part of the Ministry of Science & Technology, is still controlled by military officers. Almost certainly, the coverage will include parts of the adjacent countries with whom India is in dispute as well as its own territory. As for the high-resolution (l m or better GSD) image data from IKONOS, QuickBird, EROS, TES and Cartosat-2, it is likely that one of the principal users is the Defence Intelligence Agency (DIA) which was set up by the Indian government in 2002 after the intelligence debacle of 1999 in Kashmir, combining the previously separate intelligence organisations of the Indian Army, Navy and Air Force. In August 2005, the Indian government informed its Parliament about the setting up of a satellite based Military Surveillance & Reconnais-sance System - which is a joint operation between the country's Defence Research & Development Organisation (DRDO) and ISRO. This is due to become operational later this year (2007).

## Taiwan

In May 2004, after a long and tangled story - including a great deal of political interference from abroad concerning both the launcher and the satellite - Taiwan was able to realize its ambition to have an independent and nationally controlled high resolution satellite. This finally came about with the launch of the largely French-built ***ROCSAT-2*** satellite from the Vandenberg site in the U.S.A. using an American Taurus launcher [Fig. 2 (a), (b)]. The resulting imagery has a 24 km swath width with GSD values of 2 m (pan) and 8 m (multi -spectral) respectively. Like most modem high-resolution satellites, ROCSAT-2 can be body pointed at angles up to 45˚ from the nadir both in pitch (forward and backward) and in roll (sideways). During the long-running disputes about its construction and launch, ROCSAT-2 was said by the Taiwanese government to have been designed “to observe and monitor the terrestrial and marine environment of Taiwan and its surrounding waters”. However once it had been brought into operation, there has been a fairly general (and public) agreement that its principal role has been to produce high-resolution imagery of the Chinese mainland, especially the coastal area facing Taiwan from which an attack on the island nation could be made.

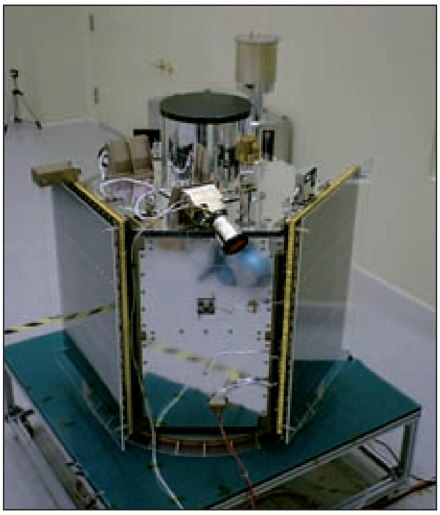


*Fig. 5 - The RazakSAT satellite being built for Malaysia by the SaTReC Initiative company in South Korea. (Source: SaTReC Initiative)*

However ROCSAT-2 is not the only source of high-resolution space imagery available to Taiwan. The country has been a long time client of the Israeli ImageSat International company. Indeed it is a Satellite Operating Partner (SOP) which gives it the exclusive right to task the EROS satellites as they pass within the footprint (2,000 km radius) of the ground receiving station based in Taiwan. This station is located in the Center for Space & Remote Sensing Research (CSRSR) of the National Central University located in Chang-Li - which can also receive imagery from the SPOT satellites. For the reception of ROCSAT-2 imagery, reportedly the Taiwanese military authorities have also built a dedicated ground station at Linkou. Besides the near real time availability of the ROCSAT-2, EROS and SPOT imagery, Taiwan also purchases IKONOS and QuickBird imagery, though, of course, this is only available after some delay.

Taiwan's interest is heavily focused on the geospatial intelligence that can be extracted from these various types of high-resolution space imagery that it acquires. According to the survey carried out by Global-Security.org, the agency that is most likely to be making use of the data for geospatial intelligence purposes is Taiwan's National Security Bureau. In particular, the Coordination Meeting for National Security Intelligence (CMNSI) - which it runs in collaboration with other law enforcement and national defence agencies - is thought to be the main conduit through which the resulting intelligence is passed on. However, it should be noted that ROCSAT-2 has been placed in a Sun-synchronous polar orbit which can provide world wide coverage. This capability is being exploited by SPOT Image which negotiated an agreement with the Taiwanese authorities to act as the exclusive world wide receiver and distributor of the imagery from ROCSAT-2 - now called ***Formosat-2*** - except for the area of Taiwan and continental China [Fig. 2 (c)]. All of which appears to be a very smart piece of business by the French organization. Not only has Taiwan paid for the construction of ROCSAT-2 with the work being carried out by EADS Astrium in France, but SPOT Image has, in this way, gained access to the ROCSAT-2 high resolution imagery to supplement

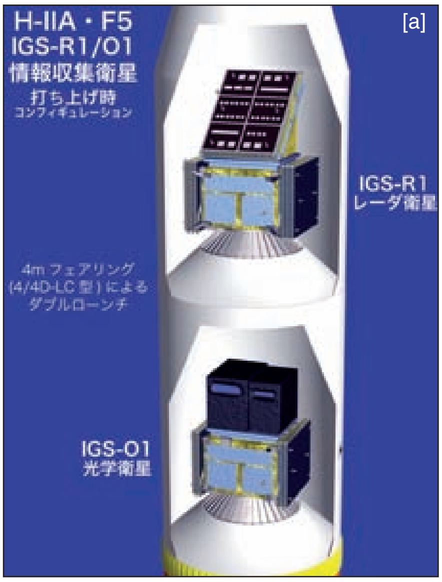




*Fig. 6* ***(a)*** *- Diagram showing the arrangement of the IGS optical (IGS-1a) and radar (IGS-1b) satellites stacked together for their tandem launch on a Japanese-built HIIA rocket.*
***(b)*** *- An artist's conceptual drawing of the IGS radar (upper) and optical (lower) satellites being operated together in space. (Source: JAXA)*

the coverage given by its own SPOT satellites without having to pay for a new satellite!

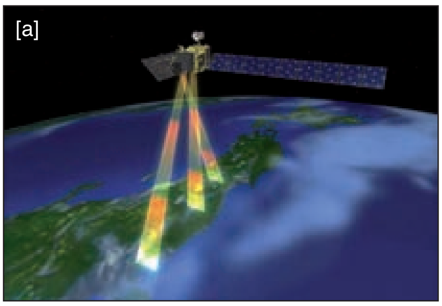
## Thailand

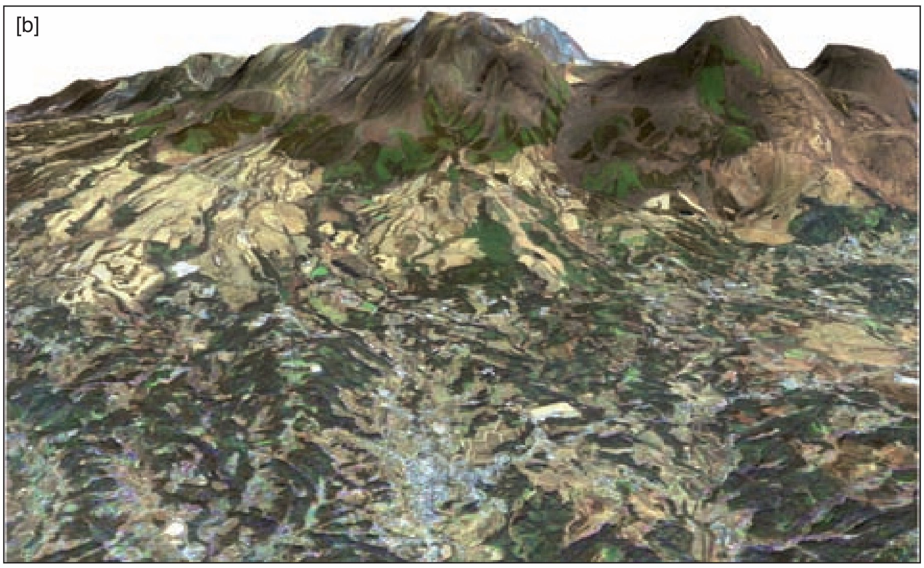
In the case of Thailand, a similar situation exists to that of Taiwan in that the government wishes to have a national capability of acquiring high resolution space imagery - with the same motivation of not being completely dependent on images from foreign countries with the delays and restrictions that this entails. Thus, in July 2004, Thailand contracted with the EADS Astrium company in France for the supply of a suitable satellite to be called ***THEOS*** (Thailand Earth Observation Satellite) [Fig. 3]. Astrium will also supply a suitable ground segment that will allow the control and operation of the satellite to be carried out directly from a Thai ground station. Currently the THEOS satellite is scheduled to be launched this coming October (2007). The specification is almost exactly the same as that of the Taiwanese ROCSAT-2 satellite. As is usual when this type of contract was announced, the main applications for the satellite and its imagery were said to be land use, agriculture, forestry, coastal zone monitoring and flood risk management. However, shortly afterwards, in a revealing interview, the general in charge of the Royal Thai Army Military Technology Center announced that "the THEOS satellite will he used for defensive purposes and intelligence gathering". In particular, it will be used to monitor the separatist insurgency in the south of the country and the drug trafficking routes crossing the country's northern and western borders. Once again, specific reference was made to the cost and delays involved in obtaining IKONOS high resolution imagery. In this context, it should also be mentioned that, in April 2005, Thailand started to operate a direct receiving station to download SPOT imagery. This is located in Bangkok.

## South Korea

Like Taiwan and Thailand, South Korea has had to seek help from foreign countries to achieve its long standing wish to acquire an independent high resolution space imaging capability, especially given the continuous threats to the country from North Korea. Initially the Korean Aerospace Research Institute (KARI) - which has led this effort - sought help from various American companies to build and launch its ***KOMPSAT-1*** satellite in 1999. Like India with its similar IRS-1C and IRS-1D satellites, the KOMPSAT-1 images with their 7 m GSD were found to he inadequate for intelligence gathering purposes. Thus the new ***KOMPSAT-2*** satellite, launched into a Sun-synchronous orbit in July 2006, has an image specification - l m pan and 4 m multispectral imagery with a 15 km swath width - similar to that of IKONOS [Fig. 4 (a)]. The satellite itself has been constructed in close collaboration with EADS Astrium in France, while the pushbroom scanner has been built by ElOp in Israel. The actual launch was carried out from the Plesetsk site in Northern Russia by Eurockot, the joint venture of EADS Astrium of Germany and the Russian Khrunichev organisation. This used the Rockot launch vehicle which is based on the Russian SS-19 ballistic missile. The main ground receiving station for the KOMPSAT-2 images is located at the KARI facility in Daejeon. Regarding the actual use of the KOMPSAT-2 imagery, military spokesmen have made clear that its main use is to monitor military installations and nuclear plants in North Korea. The analysis of the images is carried out both by the National Intelligence Service (NIS), a civilian agency equivalent to the American CIA, and the Korean Defense Intelligence Agency (KDIA), the central agency for military intelligence. Close cooperation with the United States in the area of geospatial intelligence is carried out by the Combined Intelligence Operation Center (CIOC) which also analyzes the imagery collected in overflights by U-2 aircraft - a matter of constant complaint by the North Korean government, which claimed recently that over 300 overflights had been made by U-2 aircraft during 2006. Obviously with the advent of the KOMPSAT-2 satellite, South Korea is no longer quite so dependent on U.S. supplied imagery and intel-

*Fig. 7* ***(a)*** *- An artist's impression of the PRISM three-line pushbroom scanner being operated from the ALOS satellite. (Source: JAXA)*
***(b)*** *- A perspective view of Mount Kujyu, Japan produced from pan stereo-imagery and DEM data derived from the PRISM three-line scanner and image data from the AVNIR-2 multi-spectral scanner, both mounted together on the ALOS satellite. (Source: JAXA)*



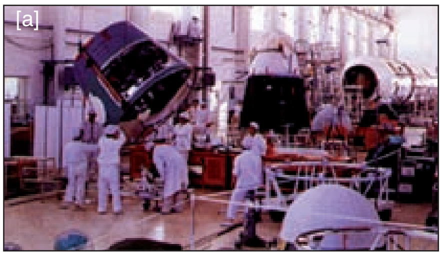




*Fig. 8 (a) - An FSW-2 reconnaissance satellite under construction in a Chinese facility.*
*(b) - A recovered capsule containing the film from an FSW-2 reconnaissance satellite.*
*(Source: GlobalSecurity.com)*

ligence as it has been in the past. This included the IKONOS imagery supplied through Space Imaging's partner company in South Korea, Space Imaging Asia, a subsidiary of the Hyundai automobile, aircraft and ship construction company. Originally this company had its own ground receiving station and processing facility in South Korea. However this now appears to have closed and has disappeared from the new GeoEye company's list of regional partners. While the distribution of KOMPSAT-2 imagery over Korea, the United States and the Middle East will remain under Korean control, the distribution for the rest of the world is being undertaken by SPOT Image [Fig. 4 (b), (c)]. This parallels the arrangement that the French company has negotiated for the Formosat-2 and THEOS satellites discussed above. It is also worth noting that, since September 2003, a ground station located in Taejon operated by the 'Agency for Defense Development' has been able to receive imagery from the SPOT satellites directly, giving South Korean intelligence agencies yet another source of high-resolution imagery.

## Malaysia

This is yet another country in the region that has decided to enter the field of high resolution imaging from space for intelligence gathering for 'national security purposes'. In 2005, the Malaysian Center for Remote Sensing (MACRES) opened a new ground receiving station at Temerloh in Pahang which receives data directly from the SPOT satellites. However Malaysia intends to supplement this source of imagery by launching its own national satellite called ***RazakSAT***. This is being built for Astronautic Technology (an agency of the Malaysian government) by the SaTReC Initiative company in South Korea [Fig. 5]. The satellite will carry a pushbroom scanner equipped with five linear arrays. One of these will produce pan imagery with a 2.5 m GSD over a 20 km swath width; the remaining four will generate multi-spectral (RGB + NIR) images with the same swath width. The unique aspect of RazakSAT is that it will be placed in a near equatorial orbit inclined at 9° to the Equator, instead of the near polar orbit that is standard for most remote sensing satellites. This means that Malaysia - which is located between 1° and 9° latitude north - will be overflown on several occasions each day. This will give more opportunities for the satellite to acquire imagery of the terrain in what is a very cloudy area with few gaps in the cloud cover. The launch of RazakSAT is scheduled for the fourth quarter of 2007 using the American Space X company's new low-cost Falcon launcher from its launch site in the Marshall Islands in the Western Pacific. The satellite will be controlled from a new ground station located at Banting in Selangor within Malaysia.

## Japan

In many ways, Japan has pursued a similar path to that of India. Initially, on the one hand, it developed its powerful H-IIA launcher; on the other hand, it developed and operated medium-resolution satellites that were used for earth resources and oceanographic applications. Then, in 1998, rather like India with its Kashmir incursion, it received a huge shock with the launch of ballistic missiles by North Korea that overflew Japan and landed in the North Pacific. Following the outcry about the lack of warning of this event, the Japanese government decided to build a constellation of 'Information Gathering Satellites' (IGS). Yet again, for political reasons, these satellites were said to be for 'scientific research' and 'disaster monitoring' - yet not a single image has ever been shown publicly. There is no doubt that, from the outset, they were designed to be reconnaissance satellites. The first two satellites in the constellation - ***IGS-1a*** (with an optical imager) and ***IGS-1b*** (with a SAR imager) - were launched together in March 2003 [Fig. 6]. The attempt, in November 2003, to place the next two satellites in the constellation - ***IGS-2a*** (optical) and ***IGS-2b*** (SAR) - into orbit failed due to a fault in the launcher. Quite a time gap then ensued before replacement satellites could be built. Furthermore the Japanese authorities also decided that the two replacement satellites should be launched separately so that both would not be lost if the launcher malfunctioned. After considerable delay, the replacement optical satellite, ***IGS-3a***, was launched successfully in September 2006. The replacement SAR satellite, ***IGS-3b***, has just been placed successfully into orbit on 24th February 2007. It was launched in tandem with an experimental optical satellite, thought to be carrying an imager with an improved ground resolution for test purposes before being incorporated into the next generation of IGS satellites.

The more civilian oriented ***ALOS*** (Advanced Land Observing Satellite) was launched successfully by the Japan Aerospace Exploration Agency (JAXA) in January 2006. The payload of this heavy (4 ton) satellite includes the ***PRISM*** high-resolution imager [Fig. 7 (a)]. This is a three-line pushbroom scanner with the forward and backward pointing telescopes producing their pan images with 2.5 m GSD and a 35 km swath at ±24° to the nadir. In many ways, it is quite similar to the HRS stereo-scanner mounted on SPOT-5 with an emphasis on the production of DEMs - though the PRISM and the Indian Cartosat-1 imager both have a smaller GSD than the HRS. Only a relatively small number of sample images from the PRISM imager have appeared so far, but they include several striking examples [Fig. 7 (b)].

Returning to the IGS high resolution imagery, according to reports in the Japanese press, the IGS optical satellites produce images with a GSD of l m, while the IGS radar satellites produce SAR images with 3 m GSD. Besides the IGS images, Japanese intelligence agencies are reported to be heavy buyers of IKONOS and QuickBird images ever since these two satellites came into service in 1999 and 2001 respectively. While the QuickBird imagery comes from the U.S.A., the IKONOS imagery is acquired locally by the ground station of Japan Space Imaging (JSI), owned by the Mitsubishi Corporation - which was a partner in the original Space Imaging company. In its drive to acquire high resolution imagery for geospatial intelligence purposes, Japan also became a Satellite Operating Partner (SOP) of ImageSat International, tasking and receiving high-resolution imagery from the EROS satellites from a ground station located at the Hiroshima Institute of Technology. Finally the ImageONE company has a direct receiving ground station at Yoni that receives images from the SPOT satellites.

Regarding the actual use of the large variety and volume of space imagery that is being acquired for geospatial intelligence purposes, it is important to note that the Japanese Self Defense Forces (SDF) come under the control of the civilian Japan Defense Agency, which is part of the Office of the Prime Minister. This arrangement is part of a deliberate policy under the Japanese Constitution to ensure civilian control of the armed forces. In line with this policy, Japan's central intelligence agency is the Cabinet Intelligence & Research Office, the so-called Naicho, which again is a part of the Office of the Prime Minister. According to various reports, the actual interpretation and analysis of the space imagery is carried out by the Cabinet Satellite Intelligence Center (CSIC). Again this reports directly to the Prime Minister's Office. Within the actual military Self Defense Forces (SDF), the main coordinating body for military intelligence is the Defense Intelligence Headquarters (DIH). This has an Imagery Division that carries out the interpretation of space imagery for purely military intelligence purposes.

## China

In recent years, a quite considerable amount of information on China's reconnaissance satellite programme has become available via a number of Chinese publications. These have been summarized by GlobalSecurity.org under the title 'China & Imagery Intelligence'. See the following Web pages - www.globalsecurity.org/space/world/chinalimint.htm From this surprisingly detailed account, it appears that China has been conducting reconnaissance satellite flights since 1975. The first series of FSW (Fanhui Shi Weixing) 'recoverable satellites' have been labelled the FSW-0 series. This undertook nine missions during the period 1975-87. The follow-on FSW-1 series consisted of five satellites launched between 1987 and 1993; while the FSW-2 series comprised three satellites orbited between 1992 and 1995 [Fig. 8 (a)]. After which, a substantial time gap occurred before the latest FSW-3 missions began, five of these having taken place between 2003 and 2005. The FSW-2 flights have typically lasted between 15 and 18 days, while the time between launch and recovery of the FSW-3 flights has been between 18 and 27 days. The usual orbital inclination of the flights (which defines their latitudinal coverage) is 63°. All of these characteristics point to the satellites being of the recoverable film type [Fig. 8 (b)], very similar to those operated by Russia till very recently. The summary articles on the GlobalSecurity.org Web site also contain references to metric frame cameras and panoramic cameras. Although understandably no details about the ground resolution of the resulting imagery are given, if indeed they follow the Russian pattern, then one might surmise that these high-resolution film cameras will deliver images that have ground resolution values of between one and three metres.

In recent years, Chinese agencies have engaged in cooperative ventures with foreign countries to gain experience in building and operating long-lived non-recoverable satellites equipped with pushbroom scanner imagers. These have included the ***CBERS*** (China-Brazil Earth Resources Satellites) with China and Brazil contributing finance and resources in a 70:30 ratio. The resulting CBERS-1 and -2 satellites were launched in 1999 and 2003 respectively using Chinese launchers. The resulting images were of medium- and low-resolution as required for earth resource monitoring over large areas. An agreement to construct and operate CBERS-3 and -4 has been reached between the two countries. However more relevant to the collection of imagery for geospatial intelligence purposes has been the collaboration between Chinese organisations and Surrey Satellite Technology Ltd. (SSTL) in the U.K. with regard to microsatellites for remote sensing. This resulted first in the construction and launch of the ***Tsinghua*** satellite in 2000 which produced medium resolution images with a 32 m GSD. However the second satellite, ***Beijing-1***, launched in October 2005, has a pushbroom scanner producing pan images with a 4 m GSD as well as the 32 m GSD multi-spectral imager. This of course places it in the category of a high-resolution satellite - those producing images with a GSD of better than 5 m. Besides the imagery from these satellites, it should be noted that the China Remote Sensing Ground Station (China RSGS) of the Chinese Academy of Sciences located at Miyun receives image data directly from the French SPOT satellites.

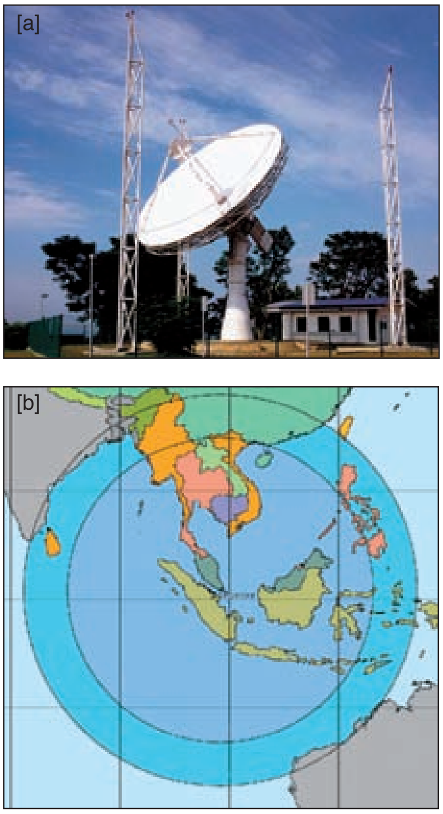


*__Fig. 9 (a)__ - The large 13 m diameter X-band antenna of the CRISP ground receiving station located in Singapore. (Source: CRISP)*
*__(b)__ - The coverage diagram for CRISP's ground receiving station for radii of 3,000 km (for satellites orbiting at 800km) and 2,300 km (for satellites operating at an altitude of 700 km), showing how it covers all the countries of South East Asia. (Source: CRISP)*

Whatever the actual or potential uses of these various types of imagery by China for geospatial intelligence, even more attention is being paid by intelligence gathering agencies world wide to the test of an ASAT (Anti-SATellite) weapon conducted by China on 11th January 2007. This resulted in the destruction of a disused Chinese meteorological satellite producing a huge field of debris that is causing great concern to all operators of satellites in low orbits. However the implications of this action in relation to the many satellites that are currently being used to collect high-resolution imagery for geospatial intelligence purposes is causing a great deal of thought and debate world-wide.

## Conclusion

Finally it is worth mentioning that two other countries in South East Asia - Singapore and Indonesia - have not yet entered the business of operating satellites for high-resolution imaging purposes, though both countries have launched micro-satellites. However they both also operate ground stations that can receive images from foreign high-resolution satellites. In particular, the Centre for Remote Sensing & Processing (CRISP) of the National University of Singapore acquires imagery from the IKONOS, EROS and SPOT satellites [Fig. 9]. All of which it sells to its neighbours. There really does seem to be an insatiable appetite for high-resolution space imagery to be used for geospatial intelligence gathering purposes in this part of the world.

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