Russia encounters hurdles in satellite development and expansion

[Content preview – Subscribe to IHS Jane's Intelligence Review for full article]

Russia is working to increase the number of intelligence satellites it operates, but its fleet remains small and increasingly outdated. *Bart Hendrickx* examines the status of Russia's satellite intelligence capabilities and considers the outlook for future programmes

A spacecraft dropped out of orbit on 17 September 2015, landing via parachute in Russia's Orenburg region. The satellite's mission was classified, but its return to Earth was highly visible. Video of the re-entry and pictures of the capsule quickly became available on social media. Russian authorities released no official statements on the event, but observers were quick to identify the capsule as the descent module of Kosmos-2505, a photographic reconnaissance satellite launched from the Plesetsk Cosmodrome in northwestern Russia on 5 June 2015.

A Soyuz-2.1b rocket carrying a missile detection spacecraft at the launch site of the Plesetsk Cosmodrome on 25 May 2017. Plesetsk will remain central to Russia's space programme into the 2020s as it expands its capabilities. (PA)

1686282

The landing marked the end of an era in space-based photoreconnaissance. Kosmos-2505 - belonging to the Yantar-4K2M/Kobalt-M series of intelligence satellites - was the last such satellite to have sent back its pictures in a return capsule. The United States and China - the other two major spacefaring nations - launched their last film-return satellites in 1986 and 2005, respectively, and subsequently relied solely on digital imaging satellites that send back their images in real time via radio. Only Russia continued to use film-return technology.

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

[Continued in full version…]

Film return to digital

The Soviet Union developed three families of film-return photographic reconnaissance satellites - Zenit (nine types flown on more than 500 missions between 1961 and 1994), Yantar (five types flown almost 180 times between 1974 and 2015), and Orlets (two types flown 10 times between 1989 and 2006), based on figures compiled by *Jane's* from open sources. Some were used for making relatively low-resolution images of wide swaths of territory (area-survey satellites), while others were used for photographing particular targets of interest (close-look satellites). There were also specialised satellites that delivered stereo imagery (two images of the same area taken from different angles) to update military topographic maps.

The bulk of these satellites were designed and built by the Central Specialised Design Bureau (Tsentralnoe spetsializirovannoe konstruktorskoe byuro: TsSKB) and its affiliated Progress factory in Kuibyshev (the city was renamed Samara in 1991). The bureau and the factory were merged in 1996 to form the State Research and Production Rocket Center 'TsSKB Progress'.

Drawbacks of film-return satellites were the limited supply of film that they could carry - hence, their limited lifetimes - and, more importantly, their inability to return images in timely fashion. In 1976, the US orbited the first of its Kennen satellites that used charge-coupled device (CCD) technology, rather than photographic film, to send back images to Earth in real time. Later renamed Crystal, 14 more of these satellites have been launched since, four of which are currently in orbit.

Details of the Kennen/Crystal satellites remain classified. However, based on assumptions about the limited details available in open sources, it is possible to estimate that the satellites would have a theoretical ground resolution of about 15 cm per pixel. The satellites relay images to Earth via data relay satellites in highly elliptical and geostationary orbits.

The Soviet Union did not launch its first electro-optical reconnaissance satellite until December 1982. It used the satellite bus of the Yantar film-return satellites and a traditional camera incapable of matching the resolution of Kennen/Crystal's mirror telescope. It also carried an infrared camera for night-time photography. The images were relayed to Earth via a newly developed geostationary satellite called Geizer. The first-generation satellites (Yantar-4KS1 or Terilen), with an estimated resolution of 1.0 m from an altitude of 200 km, were launched nine times between 1982 and 1989. An improved second-generation satellite (Yantar-4KS1M or Neman) with sub-metre resolution registered 15 launches between 1986 and 2000. Flight duration was gradually increased from six months to more than one year, but even that was much shorter than the multiple-year missions flown by the Kennen/Crystal satellites.

It was not until 1983 that the Russian government approved the development of satellites that came closer in performance to Kennen. For that purpose, LOMO, the Leningrad Optical Mechanical Association, was ordered to build optical systems designated 17V317 and 17V321 incorporating a telescope with a 1.5 m diameter mirror. According to later press reports and public statements, the 17V317 system was to fly on satellites called Araks (to be built by NPO Lavochkin in Moscow) and the 17V321 system on satellites named Sapfir (to be built by TsSKB Progress).

[Continued in full version…]

Operational digital satellites

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

When the last of the Yantar-4KS1M/Neman satellites was deorbited in early May 2001, Russia was left without any digital reconnaissance satellites in space and had to be content with periodic launches of film-return satellites that spent no longer than three months in orbit. In 2000, the Russian Ministry of Defence awarded a contract to TsSKB Progress (renamed Rocket Space Center Progress or RKTs Progress in 2014) for a new-generation digital reconnaissance satellite called Persona.

Although Persona is an outgrowth of the Yantar/Neman design, reporting in open sources suggest that they incorporate significant improvements that enable the satellites to remain operational for at least seven years. However, in-flight problems with many of Russia's satellites suggest that their actual lifespan may fall beneath this.

The satellites are equipped with a modified version of the 17V321 optical system, the LOMO has confirmed. The authoritative Russian space magazine *Novosti Kosmonavtiki* reported in its August 2015 issue that, according to unofficial information, the Persona programme uses three 17V321 systems originally built for the Sapfir project in 1988. In the same article, it was estimated that with a focal length of 20 m and CCD sensors having a pixel size of 10 micrometres, the optical system should provide a resolution of as high as 36 cm from an operating altitude of 720 km. *Jane's* assesses that these estimates are broadly credible.

The roughly 6.4-metric-ton Persona satellites are launched by the Soyuz-2.1b rocket from Plesetsk and are the first Russian spy satellites to fly in sun-synchronous orbits, enabling them to pass over the same regions at around the same local time each day. The satellites relay images to Earth via new-generation data relay satellites called Garpun, two of which were launched in 2011 and 2015 as Kosmos-2473 and Kosmos-2513, respectively.

After a delay of several years, the first Persona satellite was launched as Kosmos-2441 on 26 July 2008, but the Russian media reported that it was lost barely two months later because memory boards in its on-board computer had been rendered useless by charged particles. The next satellite, Kosmos-2486, fitted with hardened electronic components that reportedly doubled its cost, went up on 7 June 2013 but quickly encountered difficulties. The satellite was crippled by serious software problems in November 2013, according to Russian newspaper *Kommersant* . The same report claimed that following a plea from Russian president Vladimir Putin to save the satellite, a programmer of RKTs Progress came up with a solution that enabled the satellite to return to normal operations by August 2014. While the details of this report cannot be corroborated by *Jane's* , it is credible that the satellite could have experienced initial problems that were overcome. The third Persona (Kosmos-2506) was launched on 23 June 2015 into an orbit synchronised with that of the second satellite to provide maximum coverage of areas of interest on Earth.

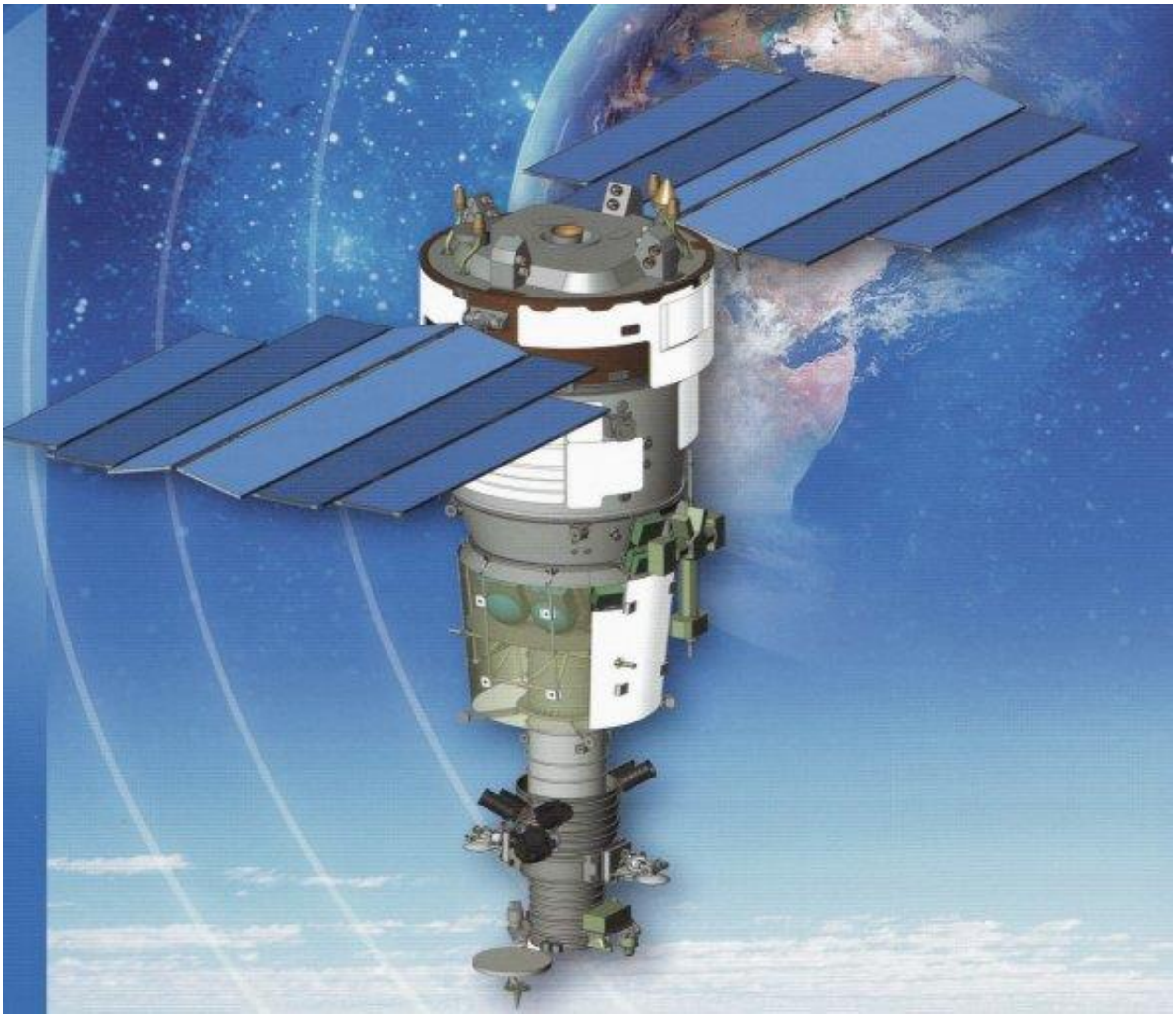
[Continued in full version…]

RKTs Progress is working on a new generation of digital reconnaissance satellites called Razdan (referred to in company documents only as 14F156), *Kommersant* reported in 2016, quoting anonymous industry and military sources. According to that report, these will have a "principally new payload" and send back images at high speed via encrypted radio channels.

Per the article, the first of these is expected to fly from Plesetsk in 2019, followed by two more in 2022 and 2024. The third satellite and subsequent ones will reportedly have a new telescope with a more than 2 m diameter mirror developed by the Zverev factory in Krasnogorsk, implying that the first two satellites will carry another payload.

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

One factor that could delay the programme is the need to replace imported electronic components by Russian ones as a result of Western-imposed sanctions introduced following the Russian annexation of Crimea in 2014. RKTs Progress ordered a study in July 2015 to investigate this issue, according to the *Kommersant* article.



An artist's impression of the Resurs-P non-military Earth observation satellite, a modified version of the Resurs-DK spacecraft. Russia currently has three Resurs-P satellites, supporting its military capabilities. (Samara Space)

1509767

Meanwhile, Russia has also introduced a digital topographic mapping satellite to replace the film-return Yantar-1KFT/Kometa series, which last flew in 2005. The original version of the satellite (Bars) was conceived in the early 1990s, but it took almost 20 years for a modified version (Bars-M) to be launched. The first one, Kosmos-2503, was launched by a Soyuz-2.1a rocket from Plesetsk on 27 February 2015, and the second one, Kosmos-2515, went into orbit on 24 March 2016. Both circle the Earth in sun-synchronous orbits at an altitude of about 560 km. Built by RKTs Progress, the 4.0-metric-ton satellites use a newly developed unpressurised satellite bus and an imaging complex called Karat built by the LOMO, which can cover a swath of 1,340 km with a maximum resolution of 1.10 m in seven spectral bands, according to press reports and company statements. The satellites have a five-year design lifetime, and at least four more are known to be under construction.

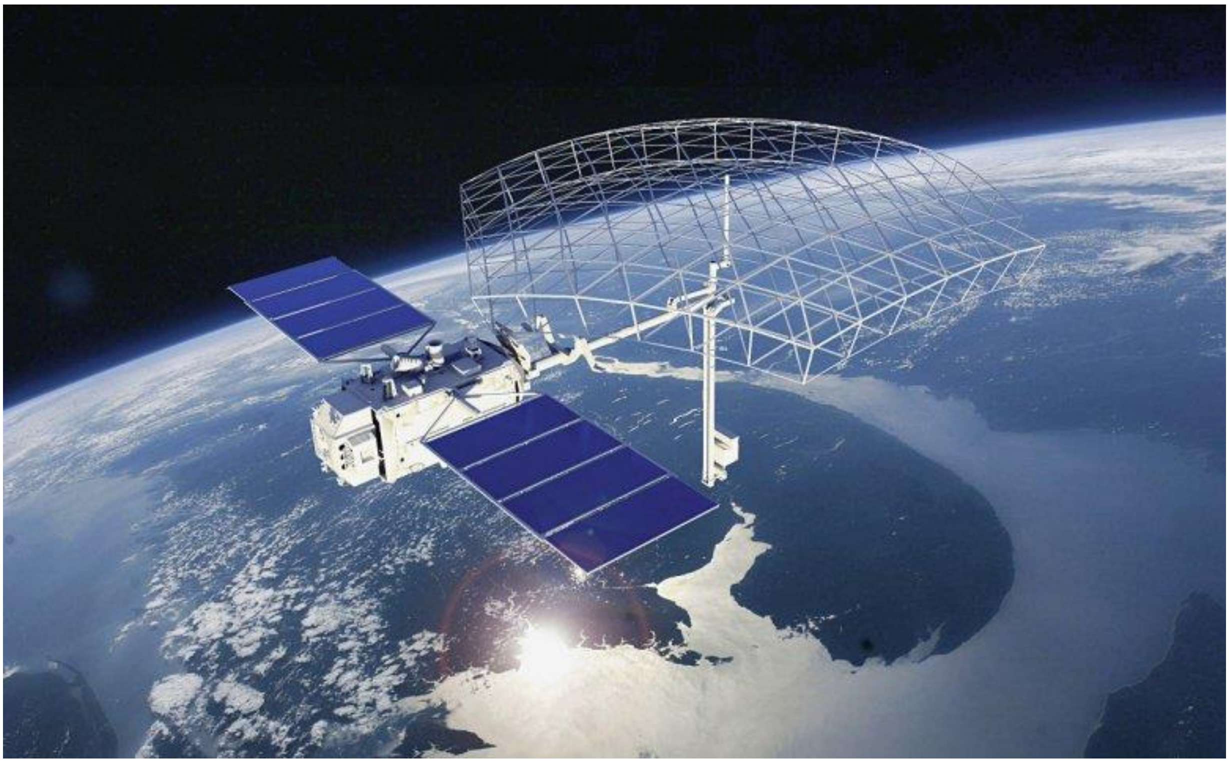
© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

Like the US military, the Russian military relies on civilian remote sensing satellites to augment the imagery received from reconnaissance satellites. The lower resolution of the imagery coming from these civilian satellites is nonetheless sufficient for such tasks such as recognising types of fighter aircraft and identifying buildings for target selection. Russia currently has four such satellites in orbit: three Resurs-P satellites and the Kanopus-V satellite. Resurs-P, an RKTs Progress satellite derived from the Yantar satellite bus, has an imaging payload with a ground resolution of 0.7-1.0 m in panchromatic mode and 2.0-3.0 m in colour mode. Kanopus-V, built by NPP VNIIEM in Moscow, has a resolution of 2.1 m in panchromatic mode.

[Continued in full version…]

Radar reconnaissance

In addition to electro-optical satellites, Russia also operates satellites that use synthetic aperture radar to provide imagery at night and through cloud cover. The US began flying dedicated military radar satellites in the late 1980s. The Soviet Union orbited radar-equipped satellites derived from its Almaz military space stations in 1987 and 1991, but the programme was discontinued after the fall of the Soviet Union. In the mid-1990s, the Russian Ministry of Defence ordered the development of a smaller satellite called Kondor. Built by NPO Mashinostroyeniya in Moscow, it was outfitted with a 6 m diameter S-band synthetic aperture radar with a maximum resolution of 1 m. After numerous delays, it was launched by a Strela rocket from Baikonur on 27 June 2013 under the name Kosmos-2487, ending up in a 500 km orbit inclined 74° to the equator. Observations by amateur observers suggest that the satellite has not performed any manoeuvres since September 2015, raising doubts as to whether it is still operational.



An artist's impression of the Kondor-E synthetic aperture radar satellite. The Kondor-E was the export version of the original military Kondor, which no longer appears to be operational. (NPO Mashinostroyeniya)

1686281

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

Based on information available in public documents, including satellite launch contracts, Russia is expected to orbit new radar satellites called Kondor-FKA and Obzor-R before the end of 2020, but these satellites are mainly intended for civilian use. However, in October 2016, the newspaper *Izvestia* reported that the Russian Ministry of Defence had awarded a contract to NPO Lavochkin to build a fleet of five dedicated military radar satellites, the first of which is expected to fly in 2019. Equipped with an active phased array radar, the satellites should orbit the Earth at an altitude of about 2,000 km and have a resolution of less than 1 m. According to the *Izvestia* report, the satellites will be built on the basis of an existing satellite bus called Navigator already being used by the Elektro-L weather satellites and the Spektr-R astrophysics satellite.

[Continued in full version…]

SIGINT and maritime surveillance

Another way to obtain intelligence from satellites is via the interception of signals. SIGINT can be broken down into communications intelligence (COMINT), the interception of voice communications, and electronic intelligence (ELINT), the interception of non-communication signals. The primary targets for ELINT are signals emitted by radars, such as those used for early warning of ballistic missile launches. By determining their location and operating characteristics, it may be possible to circumvent or neutralise these radars through direct attack or electronic counter-measures.

The Soviet Union launched several generations of SIGINT satellites (Tselina-O, Tselina-D, and Tselina-2) into relatively low orbits (500-850 km) suited mainly for ELINT. Both the satellites and their launch vehicles (Tsyklon-2 and Zenit-2) were products of a Ukrainian company (KB Yuzhnoye), which is one of the reasons the programme petered out after 1991, when Ukraine became independent from the Soviet Union. The last Tselina-2 satellite was launched in 2007.

The Soviet Union also had a very active naval surveillance satellite programme, the main purpose of which was to pinpoint the location of enemy vessels to provide accurate targeting data for anti-ship missiles. Two types of satellites were flown. One of them, the US-A, located naval vessels from a mean altitude of 250 km using radar systems powered by a nuclear reactor. After three mishaps with the reactor (one of which resulted in radioactive debris crashing in Canada in 1978), the programme was terminated in 1988. The other satellite, the US-P, spotted naval targets from a mean altitude of 430 km by detecting their radar and radio emissions. The last of these was launched in 2006 and remained operational until 2008.

In the early 1990s, the Russian government decided to cut costs by having a single company build SIGINT and naval surveillance satellites using a common satellite bus. The contract was awarded to KB Arsenal in St Petersburg, which had also built the US-A and US-P satellites. Known as Liana, the programme consists of two components - Lotos-S, a 6.0-metric-ton satellite using ELINT equipment to perform the same functions as the Tselina satellites but from 900 km orbits, and Pion-NKS, a 6.5-metric-ton satellite equipped with both ELINT sensors and radars to fulfil the same role as the US-P and US-A satellites from 500 km orbits. The programme underwent significant changes after its conception, switching from the Ukrainian-built Zenit-2 to the lighter Soyuz-2 rocket and to the same satellite bus used by the Yantar optical reconnaissance satellites.

[Continued in full version…]

The satellites are also probably capable of performing COMINT, benefiting from the experience gained during tests of experimental COMINT sensors flown on four dedicated Tselina-R satellites

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

between 1986 and 1993. However, unlike geostationary satellites, which can permanently monitor communications in a given area from their position high over the equator, the much lower orbiting satellites of the Liana constellation will make only relatively brief passes over targets, reducing the time when they will be capable of intercepting relevant communications.

Some evidence suggests that ISS Reshetnev, a company based near Krasnoyarsk (Siberia), may have been developing SIGINT satellites destined for highly elliptical and/or geostationary orbits, but the status of the project is unclear.

The main photograph shows a delegation led by Russian minister of defence Sergei Shoigu inspecting an information board during a visit to ISS Reshetnev on 6 June. Inset A shows a section of that board, including what appears to be an image of a previously unidentified satellite. Visible on the board in inset B is the name Repei-S, suggesting the text visible at the top of image A may read Repei-V. (IHS Markit)

1701883

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.

After numerous delays, the first Lotos-S (Kosmos-2455) was launched by a Soyuz-U rocket from Plesetsk on 20 November 2009 into a circular 900 km orbit inclined 67° to the equator. Reports in Russian media suggested that the satellite was plagued by numerous software issues before it ceased operations in 2014. A new Lotos-S (Kosmos-2502) was launched by a Soyuz-2.1b rocket on 25 December 2014 and was reported to have several improvements over its predecessor, including modified software to improve its resolving power and electronic components that offer better protection against radiation. Kosmos-2502 is currently the only operational Russian SIGINT satellite and has a five-year design lifetime. The complete Liana constellation should consist of two Lotos-S and two Pion-NKS satellites, but it is unclear when the next satellites will be launched. Therefore, the system is operating far below capacity.

[Continued in full version…]

For the full version and more content:

IHS Jane's Military & Security Assessments Intelligence Centre

This analysis is taken from IHS Jane's Military & Security Assessments Intelligence Centre, which delivers comprehensive and reliable country risk and military capabilities information, analysis and daily insight.

IHS country risk and military capabilities news and analysis is also available within IHS Jane's Intelligence Review. To learn more and to subscribe to IHS Jane's Intelligence Review online, offline or print visit http://magazines.ihs.com/

For advertising solutions contact the IHS Jane's Advertising team

© 2017 IHS. No portion of this report may be reproduced, reused, or otherwise distributed in any form without prior written consent, with the exception of any internal client distribution as may be permitted in the license agreement between client and IHS. Content reproduced or redistributed with IHS permission must display IHS legal notices and attributions of authorship. The information contained herein is from sources considered reliable but its accuracy and completeness are not warranted, nor are the opinions and analyses which are based upon it, and to the extent permitted by law, IHS shall not be liable for any errors or omissions or any loss, damage or expense incurred by reliance on information or any statement contained herein.