ANNUAL REPORT 2017

PRESIDENT REPORT

THERE NOW ARE 4,256 SATELLITES ORBITING THE PLANET, 179 more than a year ago. Of the current total, 1,419 are operational. The number of satellites has grown impressively since KSAT had its first satellite contact the night of May 17, 1968.

That first satellite contact from Tromsø, Norway triggered an industrial development that became Kongsberg Satellite Services (KSAT), now the world's largest ground station service provider. That evolution was driven by enthusiastic engineers with innovative ideas.

The space sector is still a developing industry, as more satellites are being launched, the amount of data collected is increasing exponentially, and new applications are identified almost daily. Not to mention the small sat revolution and the mega constellations now being designed and implemented. KSAT plays a key role in this development. Even though the satellites are indispensable tools in information gathering, the data must be delivered to the user efficiently and without delay in a reliable and predictable manner. The data also must be converted into useful services, where actionable information – not data – is the essential. KSAT is developing its service offering in this market as well.

Consequently, in 2017 we have continued to adapt to, and help shape, our market. For satellite operations (SOP), we inaugurated two new ground stations in Punta Arenas, Chile and in Los Angeles, USA. Lamentably, our Canadian station in Inuvik, NWT still awaits Canadian Government licenses to attain operational status. The total number of antennas has grown to 138 and is still growing. I'm particularly pleased to note that our ground station in Antarctica is now our second largest, reflecting the importance of a true pole-to–pole capability. The KSAT organization also expanded in 2017.

The expansion included the establishment of three new subsidiaries, KSAT Global (Norway), CSGSI (Canada), and CSGSP (Chile). We aim for growth that complies with all applicable regulations, as compliance is essential for all users of the radiofrequency spectrum as in any other area of modern business.

Satellite based vessel detection and the focus on illegal fishery is an increasingly important sector in our operations, so in 2017, we expanded it. The total value of illegal fishing is estimated at more than 10 billion Euro per year. So we prioritize the implementation of new services that curtail illegal fishing practices. Our strong focus on multi-mission near real-time delivery of vessel detection services is the key to success.

"There was nowhere to go but everywhere, so just keep on rolling under the stars."

JACK KEROUAC (1922-1969)
IN "ON THE ROAD"

KSAT has changed over the 15 years we have been in operation. We've consistently added to our portfolio of activities and sought synergies between our business areas. Whenever Satellite Operations supports a new mission, it also creates an opportunity for the Energy, Environment and Security (EES) part of the organization. Rapid data access is important, and an EES need for more data opens new opportunities for SOP.

In our fast-paced sector, I normally don't look back. That said, this year I'll make an exception, in part because I humbly admit that the continued success for KSAT depends on its teams, and partly because experience suggests that we should take the best of the past with us when we prepare for the future. Hence, in 2017, we continued to focus on customers, unconventional and flexible solutions, and technological development.

Rolf Skatteboe

By its nature, space is a business sector in which change traditionally takes time. In the spring of 2000 I visited Denver and San Francisco to discuss a program that would evolve into the next generation, sophisticated meteorological satellites built by NASA and its contractors and operated by NOAA. In November 2017, the satellite, now called Joint Polar Satellite System no 1 (JPSS-1) was launched. Its orbiting marked the entry of KSAT into a new area. We became responsible for collection of data for operational meteorology for the world's two major meteorology organizations. Timely and reliable delivery of services with a proficiency close to 100% is one aspect. Being around till 2042 when the initial period ends is another. Should anyone doubt, we aim to be here until then and longer.

As the articles in this Annual Report reflect, KSAT has been around and intends to be around for some time. It all started with the Tromsø Telemetry Station in 1967 and the first contact in 1968. It's worth remembering that this took place only 10 years after the first satellites were launched. One of the first Norwegian computers was installed at KSAT and paved the way for the digital revolution in Norway. Innovative designs and new ideas placed Norway in the forefront. When the KSAT Svalbard satellite ground station was inaugurated in 1997, the KSAT predecessor was already middle aged. KSAT itself has become a teenager, 15 years old. I'm proud to observe that the growth of KSAT has been remarkable, more than 10% a year, in part due to the customer focus, and dedication of, the KSAT teams.

We aim to continue developing new services and to expand our operations, based on the legacy of our history. The projected growth in number of satellites to be launched in the next decade is impressive. KSAT aims to serve the international user community with new services, more ground stations and innovative solutions for more than the 50 years to come.

Rolf Skatteboe
President

THE BEGINNING

BY ARVID ØVERGÅRD
Arvid Øvergård was one of the 7 supporting this launch, he has also been station manager at the TSS. This is his reflection from this special day.

ON 17 MAY 1968, AT 3:07 AM (CET), the SCOUT rocket was launched from Vandenberg Air Force Base in California carrying the European Space Research Organisation ESRO-2B satellite, Europe's first. A few minutes later the telex message from the control centre read: "May 17, 02:07 z lift off confirmed."

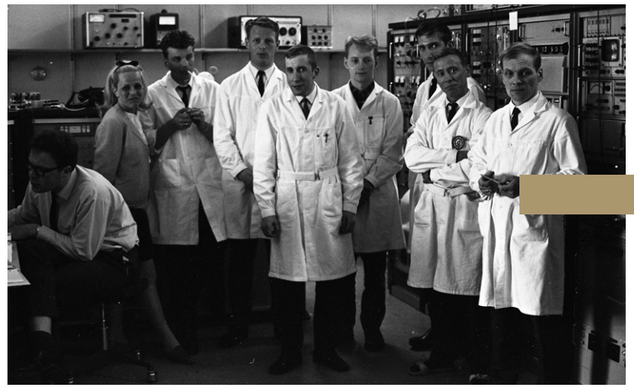
Preparations had been underway at the Tromsø Satellite Station (TSS) for several hours. But now excitement notched up.

If everything went as planned, the first signals from the ESRO-2B satellite would be received in about 100 minutes.

The preparations had actually begun in January. Simulations had been run more or less continuously, using data from the final tests of the satellite. We had direct communication lines to the European Space Operations Centre (ESOC) in Darmstadt, Germany, and the simulations had been performed as realistically as possible. But simulating a satellite flyby might differ considerably from conducting it in practice, not least because this was the first time it had been done. For both the small TSS staff and for the satellite controllers in ESOC, the event was a baptism by fire.

Not only the human staffs were new at it. The ESRO-2B was fitted with a new technology for sending signals to Earth stations. Pulse Code Modulation (PCM) had been developed and tested during the Second World War, but was far from being a routine technology. At TSS, the PCM gear was connected to a Norwegian-developed digital computer. At the time, TSS was the first station of its kind in world to have a digital computer connected to its decoding equipment. It was to become a key element in the station real-time services. Named SAM-2, the digital computer had been developed at the Norwegian Defence Research Establishment (NDRE) at Kjeller, near Oslo. It was to trigger the foundation of Norsk Data, but that's another story.

Telefax confirmes «lift off».



The team is very content having received signals from Europe's first satellite. From left side: Otto Pettersen, Mia Berglund, Kåre Amundsen, Arvid Øvergård, Jon Berg, Hans Petter Falao, Hans Magnar Pettersen, Roald Pedersen and Dagfinn Leiulfsrud.

The small TSS staff had meticulously adjusted all equipment according to ESOC instructions. We had used the nominal orbital parameters to program the antennas, consisting of azimuth and elevation look angles for the first satellite flyby. The look angles were entered into the antenna control unit to ensure smooth movement. The big question was therefore whether they were correct. Would ESRO-2B appear in the sector of sky at which the antennas aimed?

The wait was unbearably long. But Launch Control had reported that the rocket had performed as planned. The tasks at TSS had been specified concisely. Hans Magnar Pettersen was to monitor the receivers; Kåre Amundsen was to check the PCM and telecommand equipment; and my tasks were to ensure that the antenna system functioned and carry out voice contact with the satellite controllers in Darmstadt. The Station Manager, Dagfinn Leiulfsrud, was of course present, and, as a back-up, so was Roald "Pedro" Pedersen, an expert hired in from the Andøya Rocket Range (ARR) for the initial effort. The simulations had indicated that the station was considerably understaffed.

The critical instant was when ESRO-2B would fly into the antenna beam. The distance from the antenna to the satellite at that time would be about 3800 km. The predicted time to receive the signals, Acquisition of Signal, (AOS), from the satellite was set to be 03:31:00 Z.

THE EVENT

The station clock showed 03:25 Z in the telemetry room; the silence was deafening. At the receiver, Dagfinn and Hans Magnar stared at the green line on its display. They would be the first to see a received signal.

It was 3:30. Now we were watching the station. It passes 03:31:00, nothing happens! The antenna starts to move slowly as programmed. Dagfinn reaches for but doesn't move the adjustment knob on the receiver.

Has something gone wrong? Have we erred, or...?

Innumerable questions, but nobody dares answer. This is unexplored ground!

Then at 03:31:14 there's a sound from the receiver, and a spike shows in the green line; suddenly we've received a signal from ESRO-2B!

"Tromsø confirm AOS at 03:31:15;" The message is forwarded to ESOC using voice control.

"Confirm PCM-lock" Kåre reports. This means that the demodulation gear has locked onto the signal from the satellite. I immediately reports "PCM lock" to ESOC and the satellite controller confirms receiving the message. We have started the first satellite reception and "all systems are looking good." Now everything happens as simulated for the past months. The antenna elevation is increasingly higher, and the first command signals are sent to the satellite. This is a critical operation. The satellite battery capacity is limited, so its systems should be started to charge its batteries.

Everything works as planned. The dialogue with ESOC seems problem-free, and all systems are working normally.

After some nine minutes, ESRO-2B again nears the horizon, and Tromsø Telemetry Station has completed its first flyby of the first European satellite. "Tromsø reports "Loss-of Signal (LOS) at 03:40:20" is the final voice message to ESOC. The satellite controller confirms and congratulates. Now only a PASS REPORT needs be sent to ESOC. It goes out in a telex message.

Station Manager Dagfinn Leiulfsrud gives the "thumbs up" for a successful reception of the signals from ERS-2, Europe's first satellite.

We congratulate each other upon having taken part in a historical event. Europe, Norway, and Tromsø have entered the space age.

It's almost 5 o'clock in the morning of the seventeenth of May, Constitution Day, Norway's national holiday. In a few hours the traditional children's parades will start. But for the staff at Tromsø Telemetry Station it's no holiday this year. The next ESRO-2B flyby will be in about 100 minutes; thereafter it'll be non-stop.

LEGACY

The Tromsø Telemetry Station, later renamed Tromsø Satellite Station soon became a key station for the European Space Research Organisation (ESRO). Its location at high latitude enabled interaction on almost all ESRO-2B flybys. With its PCM demodulation gear connected to a digital computer, it could offer services in real time to the scientists. One problem was that because the staff was small, excessive overtime became a burden. The situation improved in the autumn when ESRO launched its next satellite, ESRO 1A in October 1968. ESRO 1A carried several Norwegian experiments that exploited the capabilities of the digital computer. It provided experimenters with data in hand just a few minutes after a satellite flyby, opening a new area for space science.

20 YEARS OF COOPERATION

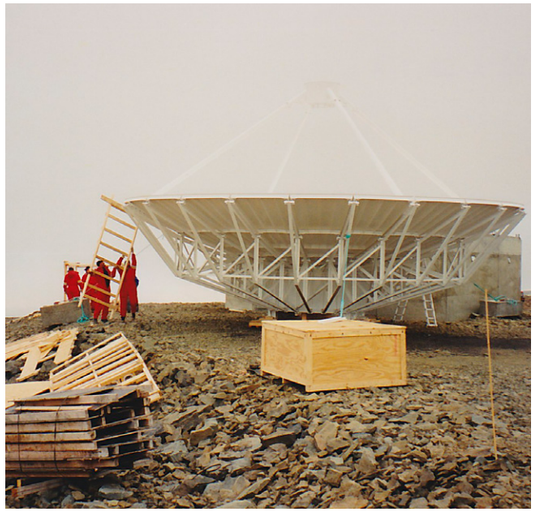
IN THE FALL OF 1997 first operational satellite pass was accessed by the newly installed SG-1 antenna at the KSAT Svalbard Ground Station, or SvalSat as it then was called.

The antenna and the associated back end equipment, were state-of-the-art, the best NASA could build. All the control electronics were packed in a custom-built trailer that had double air conditioning designed for warm areas. However, curiously it wasn't snow proof. When the first snow came in September, the operator on duty realized that emergency measures were imperative to protect vulnerable electronic components. Snow blew into the trailer from everywhere. A temporary inflatable building was the solution. It became the home of the operators at SvalSat for two years.

That was the beginning of a long lasting relationship between the National Aeronautical and Space Administration (NASA) and Kongsberg Satellite Services (KSAT). NASA needed to locate a new ground station for the satellites of the Mission to Planet Earth program, and the Norwegian Space Centre was looking for customers who could benefit from its planned ground station at Svalbard, located at 80°N, near the North Pole.

The cooperation had started some years earlier with the signing of a framework agreement between the United States of America and the Kingdom of Norway for cooperation in the civilian uses of outer space. Sounding rockets then where launched from Norway every so often. The satellite activity differed. From the newly established SvalSat station, satellite-based observations were downloaded on all 14 daily orbits of polar orbiting satellites. In the beginning about 50Mbit/s of data per satellite were downloaded to the site and immediately transferred to data centers in the US. Geostationary satellites were used, even though skeptics had claimed it wasn't possible with a mere 2.7° of elevation from Svalbard to the Goestationary satellite arc.

As the number of satellites supported from Svalbard grew, it was obvious that a cheaper means of communication was needed. Creative minds in Norway and the US jointly planned a fiber-optic communications link between mainland Norway and Svalbard. About 1800 km of Arctic waters had to be traversed with a double fiber optical subsea cable. Redundancy was part of its design, to ensure reliable communication. And to prevent damage from trawlers, the fiberoptic cables were put in an ocean valley 300m under the surface. The fiberoptic initiative changed the lives of KSAT Svalbard and of the local community in Longyearbyen. After a hectic nine month implementation, the local community gained broad bandwidth that supported Internet and TV. Today, everyone takes fast communication at reasonable cost for granted, but it is only a little more than 20 years since it was implemented. It also ended the era of data storage on tape. Until then, all data were stored on large tape drives, and tapes were manually loaded and shipped to the USA, one big box a week. Nobody wept when the eight tape drives that had cost $250,000 each disappeared.



In November 2017, another milestone in the cooperation in an archipelago at Svalbard took place. NASA launched JPSS-1, the first satellite of the Joint Polar Satellite System. It was the world's most advanced satellite for meteorology observations, and its primary ground station is at Longyearbyen in Svalbard. In retrospect, it's worth mentioning that support for this satellite was first discussed in the autumn of 2000. So it took more than 17 years to realize and launch the satellite. That's a relatively long time, but until now, it has been a typical timeframe for supporting orbiting satellites that are the size of a small bus and cost about one billion US Dollars. Today, KSAT supports NASA with more than 30 passes per day from six different antenna systems.

The partnership between NASA, NSC and KSAT evolves continuously. The main focus for the next couple of years will be new technologies for satellite operation as well as implementing new downlink frequencies. KSAT and NASA have designed a matrix system allowing multiple satellites to be supported from multiple antennas. Hence, the efficiency of the station has been enhanced at minimum cost. As the volume of data increases, downlinks have migrated to progressively greater bandwidths available at higher frequencies. Moving from X-band to Ka-band will increase the downlink rate from about 720 Mbit/s till about 5 Gbit/s. The JPSS-1 satellite downlinks are in the Ka-band, a first for operational satellites.

When the NASA-NSC/KSAT crew first was lifted to the Plateau above Longyearbyen, it was a wild plain with no structures. The team-to-be buried a Norwegian ten kroner and US one dollar note and built a small pyramid marking the spot. The pyramid is long gone, blown away by wind and snow, but a monument has come in its place. The KSAT satellite ground station, originally designed with one antenna provided from NASA now has almost 40 antenna installations. And it is still growing.

BY M. MICHAEL BRADY

M. MICHAEL BRADY
M. Michael Brady was educated as a scientist. He worked in telecommunications R&D before turning to editing, writing and translating.

50TH ANNIVERSARY OF NORWEGIAN SATCOM

Pole story

IN THIS INVITED ESSAY, M. Michael Brady reviews the five-decade history of Norwegian satellite communications.

A maxim in economic history holds that "Never in history has man successfully invented a device, an instrument, a machine, or a structure without creating a demand for performance far beyond the capacity of the original design." This is particularly true of Norwegian satellite communications, the story of which began on the 17th of May 1968, with the first reception of a signal sent by the European Space Research Organisation (ESRO) 2B astrophysical research satellite at the Tromsø Telemtry Station (TTS).

At the time, satellite communications was a scientifically well founded yet less proven concept. It had first been proposed in 1929 in a small monograph in German by Hermann Nordung, a pseudonym of Captain Potocnik of the old Austrian Imperial Army. In 1945, sci-fi writer Arthur C. Clarke made it more widely known in English in an article in the October issue of Wireless World. In 1962, the Telstar satellite relayed the first public television signals across the Atlantic from Europe to North America, and in 1963, Intelsat I, the first commercial communications satellite, was launched into geosynchronous orbit.

ESRO was founded in 1964 to pursue scientific research in space. In turn, in 1965 in Norway, TTS was proposed as an earth station dedicated to receiving signals from satellites and sounding rockets and specifically built to be ready in time for the launch of the ESRO 2B satellite. In January 1968 TTS was operational and ready for the ESRO 2B polar orbiting satellite launch. 4 months later the first signal from it was received at TTS.

The rest is history. Growth came apace. TTS became Tromsø Satellite Station (TSS) in 1987, and is now owned by KSAT, a joint venture of the Kongsberg Group and Space Norway (SPN), a company owned by the Norwegian Ministry of Trade, Fishery and industry. TSS was merged into KSAT and the company now owns and operates 20 satellite ground stations round the world. Together the stations use more than 140 antennas to receive data from and send command signals to satellites in polar orbit.

The phenomenal growth of KSAT is an epitome of the era in which it took place, reflecting the aspects of both coincidence and causation that trigger technological progress. The aspect of coincidence is like that of having "the three things that matter most in property: Location, Location, Location." The former TSS is at Tromsø, 375 km north of the Arctic Circle, an ideal location to communicate with satellites in polar orbits, which is why ESRO proposed that TSS be built. The aspect of causation arose at the Norwegian Defence Research Institute (NDRE), founded in 1946 and long Norway's high-tech research institute of choice. One leading career researcher there was Karl Holberg (1921-1999), who understood early the potential of digital computers and as the director of the Electronics Division oversaw the development of the SAM-2 computer and its interconnection to the PCM demodulator that enabled reception and decoding of the first ESRO-2B satellite signal. He also was involved in cybernetics, a pursuit that led in 1973 to his becoming involved in Norway being the first country outside the USA to be included in the ARPANET, one of the two precursor technologies of the Internet; but that's another story.

After the successful reception of the ESRO 2B signal in 1968, Norwegian satellite communications grew expeditiously:

- In 1976, maritime satellite communications tests were conducted using the satellite earth station near the village of Eik in Rogaland County. Their success led to the foundation of Inmarsat in 1979, and the Eik earth station is the largest in the Nordic countries.
- In 1986, The Telenor Satellite Broadcasting earth station began operation in Nittedal, a suburb to the north of Oslo. Today (2018) it is the busiest earth station in the Nordic region, with more than 50 antennas.
- In 1987, Norway joined the European Space Agency (ESA) and founded its own national agency, the Norwegian Space Centre.
- In 1997, the Svalbard Satellite Station (Svalsat) started operation near Longyearbyen, the administrative centre on Spitzbergen. It now (2018) has 40-50 antennas owned by KSAT serving EUMETSAT, NASA, and the National Oceanic and Atmospheric Administration (USA) among others.
- In 2007, KSAT started operation of the TrollSat satellite station near the South Pole in Dronning Maud Land on Antarctica.

In five decades, satellite communications in Norway have advanced from an ethereal possibility to a mainstream reality.

FURTHER READING:

The economic history quote is from "Relative Prices in the Nineteenth Century" by D.S. Brady, in the Journal of Economic History, Volume XXIV, June 1964, No. 2, pp. 148-203.

Das Problem Der Befahrung Des Weltraums ("The Problems of Space Travel") by H. Noordung, Berlin, 1929, Richard Carl Schmidt & Co., reprint by Turia & Kant, Vienna, 1993, ISBN 3-85132-060-3, the book with the first known drawings of satellite communications, Figures 54 and 55, pages 98-99.

Estra-terrestrial relays, by Arthur C. Clarke, in Wireless World (British radiofrequency communications and electronics monthly journal), October 1945 issue, pp. 305-308.

The "Location, Location, Location" quote often is attributed to British real estate tycoon Lord Harold Samuel (1912-1987), but as pointed out by language oracle William Safire in the June 26, 2009 edition of the New York Times Magazine, appeared first in 1926 in a real estate classified advertisement in the Chicago Tribune.

The Norwegian Space centre, periodically updated overview brochure in Norwegian and English editions, PDF downloadable at https://www.romsenter.no/eng/

A comprehensive overview of the space sector in Norway is provided by the Norwegian Ministry of Trade and Industry White Paper "Between heaven and earth: Norwegian space policy for business and public benefit", *Meld. St. 32 (2012-2013) Report to the Storting,* Oslo, December 2013, 82 pages, downloadable free in RTF, PDF, or EPUB format from the Norwegian Government website.

EVENTS 2017

JANUARY

The new Observation room at Svalbard Ground Station inaugurated

Earth Capture, our new analysis tool developed in-house, used to deliver services to our customers for the first time

The Norwegian Prime Minister Erna Solberg, the Prime Minister of Finland Juha Sipilä and Secretary General Petteri Taalas of the World Meteorogical Organisation, WMO visited KSAT

Supported PLSV from India with 109 satellites – new world record for satellites launched with one rocket

FEBRUARY

KSAT enters agreement with Virgin Galactic for LauncherOne

KSAT[LITE] at The SmallSat Symposium 2017

KSAT and Astro Digital team up to revolutionize the collection and delivery of big data

Ka-band capability included into the KSAT[LITE] portfolio

New technology project initiated EXSS II (Extended Services for SOP) defines next generation SOP services

Installed several antennas at Svalbard and Troll during Arctic winter and Antarctic Summer.

MARCH

KSAT's OUTdoorSPACE gives the people of Tromsø different short movies projected on one of our antennas

Punta Arenas development initiated. Six months from Green field till operational station.

KSAT Global gets two subsidiaries, Canadian Satellite Ground Station, Inuvik (CSGSI) and Chilean Satellite Ground Station, Punta Arenas (CSGSP).

Pilot service (ice detection) for NOFO in the Barents Sea

26.000 pass this month, the growth continues

APRIL

The new station building in Svalbard inaugurated after reconstruction and expansion

KSAT participating at the Navy League Sea Air Space Tradeshow in Washington DC

@National space symposium: Great turn-out on the "Taste of Norway"-event

KSAT sponsored and participated with many employees at Reistadløpet, a 34 km cross-country ski race

Vessel detection v 4.0 initiated. Service for the future

Contract signature with Siwei observed by the Norwegian Minister for Trade and Industry and the Norwegian Minister of Foreign affairs

KSAT Internal seminar, in Tromsø this time

NASA's P3 Orion visited Svalbard on a research mission

MAY

Bernice Notenboom, Dutch climate journalist, adventurer and polar explorer, and The 2 Degrees Expedition visit at Svalbard Ground Station

No year without the KSAT-team running the Holmenkollen relay

Open day at Svalbard Ground Station

The International Oil Spill Conference (IOSC) in Long Beach California together with world leading Norwegian oil spill preparedness and response companies

To take advantage of the nice weather, various shifts work continuously 24/7 over several days to install SG 11 on Svalbard

KSAT[LITE] presented at the UK Space Conference – Our ground network optimized for small satellites and large constellations

Second antenna installed Mauritius (Cosmic II)

NASA / NOAA JPSS, Contract extension negotiations (2036)

JUNE

Pilot/demo illegal fisheries in Gabon

Initiated discussions with Space Norway for support to the HEO communication project

KSAT supported 7 launches during June

JULY

KSAT[LITE] record: 10.000 passes, out of a total of 33.000 passes for KSAT antennas

Fourth of July visit from US Congress on Svalbard Ground Station

AUGUST

KSAT @Smallsat Utah

KSAT supports Stokes Nature Center and some supercool drawings of penguins and polar bears were presented

KSAT supports Arctic Race of Norway

Tenant meeting with a special anniversary edition taking all the participants up to 80 degrees North!

Svalbard Space Run, with the finish line up between our antennas

Launch of "Orbit" our space Ale – at Rakettnatt a musical festival in Tromsø

SEPTEMBER

@IAC Adelaide – KSAT presented a paper on the opening day.

SG54 radome installed without problem

20 anniversary party of Svalbard ground station with employees, partners, suppliers and special guests

The Svalbard KSAT-team finishes in 3rd place at the annual TV-fundraising relay in Longyearbyen

OCTOBER

Katherine Monson, our new Director of Business Development USA.

KSAT Total: 35.000 passes pr month

NOVEMBER

KSAT ground station in Punta Arenas was officially inaugurated by Norway's Ambassador to Chile, Mrs Beate Stirø.

JPSS-1 was launched November 18th. KSAT supported the launch from Svalbard and Troll. This satellite is also using our tri-band antennas; SG22 and TR2, transmitting in S, X and KA-band

EMSA Clean Sea Net 10 years

KSAT celebrates 50 years of space activity in Tromsø – national seminar with policy-makers, industry and stakeholders – and a space party

DECEMBER

KSAT supported GCOM-C1, successfully launched from Tanegashima Space Center i Japan

Earth-i to use KSAT to Receive First Commercial Full-Colour Video From Space

The Danish Meteorological Institute (DMI) ice service has from November 1st based their in-shore ice charting around Cape Farewell in the southern part of Greenland on satellite imagery from Kongsberg Satellite Services (KSAT)

Recruitment initiative started. 20 new positions to be filled next year.

ANNUAL REPORT

ABOUT KSAT

Kongsberg Satellite Services AS (KSAT) supplies services for the operation of and acquisition of data from satellites, as well as for the applications of satellite-based information in global services.

As of 31 December 2017 KSAT has three wholly-owned subsidiaries: KSAT Global; CSGSI (Canadian Satellite Ground Station Inuvik) a company incorporated in Canada; and CSGSP (Chilean Satellite Ground Station Punta Arenas) a company incorporated in Chile. In addition, KSAT has activities at fixed locations in the USA, Panama, South Africa, Mauritius, Dubai, Turkey and Singapore. The Annual Report cover the activity in the Parent Company. KSAT Global is the owner of the KSAT infrastructure as well as its subsidiaries.

KSAT is a world leader in its markets and has two business segments. Ground Station Services comprise about 85% of turnover. Its Energy, Environment, and Security (EES) Division services based on satellite information comprise about 15% of turnover. The activities of these segments comprise operation of ground stations that communicate with satellites, near real-time reception and processing of Earth Observation data, and services in the operational uses of these data. The company focuses especially on marine applications of satellite based Earth Observation information, for clients in the oil and gas sector and the public sector.

KSAT's headquarters are in Tromsø, and the company operates 21 ground stations in various countries. Operations are controlled at the Tromsø Network Operations Center (TNOC), which is co-located with the company headquarters. KSAT has local offices in Svalbard, Oslo, and Stockholm.

During the year, the KSAT staff expanded by 13 to 166 by the end of 2017.

KSAT is owned 50/50 by Space Norway AS, a State-owned enterprise (SOE) of the Ministry of Trade, Industries, and Fisheries, and by Kongsberg Defence & Aerospace AS (KDA), part of the Kongsberg Group ASA.

STATUS

In 2017, operating revenue was MNOK 752,6 an increase of 21.8% from previous year. The order income was MNOK 1,037. As anticipated, positive development continued in 2017. KSAT is the only company supplying ground station services from both Polar regions, and its Pole-to-Pole concept is optimized for effective satellite control and data downloading. KSAT services have been augmented by mid-latitude stations, and a dedicate KSAT^{LITE} ground segments aimed to fulfill the needs of new client groups, helping to fuel the smallsat revolution. After two difficult years, the EES Division achieved good results with a margin of 7%. New Small Sat initiative KSAT^{LITE} has been successful, however this is a marked segment with low margins. KSAT is working to reduce opex to increase the margins.

KSAT routinely supplies operational, near real-time marine services and products as relevant for shipping, iceberg detection, and oil spill detection. Monitoring of illegal fisheries is a developing sector.

KSAT has long-term contracts with most leading space agencies as well as with key commercial actors. This stable client base ensures long-term operational capability. Consequently, the company can focus on continued growth, innovative improvements, and establishing new business segments.

KSAT is the world's largest supplier of services for controlling and acquiring data from polar-orbiting satellites. Antenna capacity went up in 2017, and by the end of the year, the company operated about 138 antennas and conducted 34,000 satellite contacts per month, involving more than 100 satellites. KSAT supplies ground station services to the ESA/EU funded Galileo and Copernicus satellite systems. 93% of company turnover is outside Norway.

Activities focus on expansion of the ground network with several integrated ground stations and the establishment of global, multi-mission, near real-time monitoring. KSAT's international leading position builds on its operational experience, technical expertise, and cost-effective infrastructure, combined with unique geographic locations. Moreover, the company draws upon 20 years of experience in developing and supplying satellite-based services focused on maritime applications. At the end of 2017, KSAT had antennas at 21 locations round the globe.

Work continues to improve the accessibility of data from KSAT ground stations. KSAT now is the world's only company with internal processing capabilities for ll operational radar satellites. KSAT seeks innovative solutions for establishing new services, focusing on the High North in general and on environmental monitoring in particular. KSAT works together with UnoSat, the United Nations satellite agency, and contributes to the use of satellite data in disaster and emergency aid activities.

FINANCIAL RISK

A notable part of KSAT's revenue is in US Dollars (USD) and Euro (EUR), which incurs exposure to exchange risk in ordinary business activities. Safeguarding contracted turnover through hedging is used through contractual forward exchange agreements.

KSAT has low interest risk, as the debt is mainly non-interest bearing, and as KSAT has a cash pool arrangement that incurs only net interest for the company. This gives the company ample liquidity and freedom of action.

The company evaluates the credit rating of each new client and takes precautions if necessary. The credit risk is small for KSAT's largest clients. Clients and suppliers are evaluated to ensure that all activities comply with applicable rules for business ethics, anti-corruption and general social responsibility.

OPERATIONAL RISK

KSAT is a service provider that depends on operational satellites and other technological equipment to download and process data from satellites. Failed launches, orbiting satellite malfunctions, or faults in KSAT antennas and other facilities may affect development. Operational income from TrollSat in Antarctica is vulnerable to equipment breakdown and the like.

BUSINESS RISK

Business risk is associated with changes in the primary market, escalating competition, and competitive access to data from satellites.

GOING CONCERN

Annual accounts are prepared on the basis of going concern.

EVALUATION OF CASH FLOW

In the cash flow analysis, cash and cash equivalents are entered as the net of bank deposits and short-term debt to credit institutions as these accounts are included in the cash pool arrangement.

In 2017, the net cash flow from operational activities was NOK 272 million, compared to NOK 196 million in 2016. Net change in cash and working capital is increased with NOK 36 million.

Cash and cash equivalents together amounted to NOK 87 million as at 31 December 2017. Company cash flow and liquidity are deemed to be good, and the net capital ratio is 62%. Working capital is 27 MNOK.

RESEARCH AND DEVELOPMENT

About 3% of annual turnover is invested in internally and externally-financed development of services. The relevant costs are expensed as incurred.

FUTURE DEVELOPMENT

Demand for KSAT services is bouyant, and development is positive in the small satellite market (new space) served by KSAT^{LITE}, and in the EES Division's market. Growth in all markets is expected henceforward. KSAT aims to secure existing and new data sources as well as to expand access to its own ground stations and to other ground stations.

The Board anticipates continued company growth. Focus will be on global services and activities in the High North. Competition is increasing from large European companies, from other companies that operate ground stations, as well as from low-cost satellite systems.

WORKING ENVIRONMENT

The KSAT working environment is deemed good. Management and staff are represented in the Working Environment Committee, respectively with three management and three safety deputy members. Two meetings were held in 2017. There were no incidents of staff personal injuries in 2017. Sick leave amounted to 4,3%. Short-term sick leave was 1,2%.

SOCIAL RESPONSIBILITY

KSAT emphasizes that values and ethical guidelines shall be integral in its activities. The staff and collaborating partners shall have high ethical standards and live up to prevailing rules. KSAT focuses on anti-corruption work and is concerned with its social responsibility. The company will unfailing live up to prevailing laws and regulations wherever it has activities.

The company contributes to society with its acquisition of satellite-based Earth Observation data, which is essential in meteorology, resource monitoring, and climate research in general.

GENDER EQUALITY

Company management comprises six men and one woman. The Board and its deputies consist of seven men and three women. The employees have two representatives on the Board. The Board and management are aware of the social expectations and measures for furthering gender equality within the company and on the Board.

The company wishes to be seen as an attractive workplace and aims for arrangements that increase the proportion of women in technical positions as well as in management. In 2017, 21% of KSAT employees were women.

MEASURES AGAINST DISCRIMINATION

The KSAT personnel policy aims to ensure equal possibilities and rights and to hinder discrimination on the basis of ethnic background, national origin, skin color, language, religion, beliefs, age, and gender.

The headquarters offices is arranged to support disabled people.

EXTERNAL ENVIRONMENT

Mainland KSAT activities have no impact on the external environment. The company now is working on green solutions for electric power production in the Svalbard archipelago and at Troll in Antarctica.

STATEMENT OF ANNUAL ACCOUNTS

The Board believes that the Annual Accounts satisfactorily describe the company position at the end of the year. The company financial position and liquidity are sound, and the Board assesses company equity to be satisfactory.

The Board is not aware of any situations not included in the Annual Accounts that may affect appraisal of company position.

ALLOCATION OF PROFIT

In 2017, the company profit after tax was TNOK 193 841.
The Board recommends the following allocation of profit for KSAT AS:

	TNOK
Dividend to owners	110,000
To other equity	83,841
Total allocation of profit	193,841

Tromsø,
31 December 2017
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14 February 2018

THE BOARD OF DIRECTORS OF KONGSBERG SATELLITE SERVICES AS

Asbjørn Birkeland
Chairperson

Eirik Lie
Deputy chairperson

Amund Nylund
Member

Rolf Skatteboe
President

Even Aas
Member

Jostein Rønneberg
Member

Gøril Bjørkmo
Member

NUMBERS AND FIGURES

ABOUT KSAT

	1000 NOK	1000 NOK	Exch. rate 8,21 1000 USD	Exch. rate 8,21 1000 USD
	2017	**2016**	**2017**	**2016**
Operating revenue	752 606	618 029	91 725	75 323
Raw materials and consumables	121 968	101 146	14 865	12 327
Personnel expenses	154 358	136 915	18 813	16 687
Other operating expences	159 252	132 219	19 409	16 114
Depreciations	75 907	57 142	9 251	6 964
Operating profit	**241 121**	**190 607**	**29 387**	**23 231**
Net financial items	122	(1 369)	15	(167)
Earnings before tax	241 243	191 976	29 402	23 397
Tax expense	43 798	36 213	5 338	4 414
Net profit for the year	**197 445**	**155 763**	**24 064**	**18 984**

STATEMENT OF CASH FLOW

	1000 NOK	1000 NOK	Exch. rate 8,21 1000 USD	Exch. rate 8,21 1000 USD
	2017	**2016**	**2017**	**2016**
Earnings before tax	241 123	191 976	29 387	23 397
Taxes paid	(32 981)	(35 561)	(4 020)	(4 334)
Profitt/loss sale of fixed assets	-2 183	0	(266)	0
Depreciation and amortisation	75 907	57 142	9 251	6 964
Change in accounts payable/receivables	(28 542)	6 351	(3 479)	774
Change in pension plan liabilities	(618)	221	(75)	27
Change in other accrual items	19 772	(24 422)	2 410	(2 976)
Net cash flow from operations	**272 478**	**195 707**	**33 209**	**23 852**
Sale of tangible fixed assets	6 373	0	777	0
Payments for aquisition of fixed assets	(194 956)	(192 345)	(23 761)	(23 442)
Purchase of investments in shares and joint ventures	0	(1 000)	0	(122)
Loan to Group Company	26 000	(26 000)	3 169	(3 169)
Paid dividend	(90 000)	(120 000)	(10 969)	(14 625)
Cash and cash equivalents at 1 January	51 704	195 342	6 302	23 808
Cash and cash equivalents at 31 December	**71 599**	**51 704**	**8 726**	**6 302**

BALANCE SHEET AT 31 DECEMBER

	1000 NOK	1000 NOK	Exch. rate 8,21 1000 USD	Exch. rate 8,21 1000 USD
	2017	**2016**	**2017**	**2016**
Assets				
Deffered tax asset	14 961	13 432	1 823	1 637
Operating Assets	642 239	527 379	78 274	64 275
Financial Fixed assets	38 425	66 628	4 683	8 120
Total fixed assets	**695 625**	**607 439**	**84 781**	**74 033**
Receivables	200 787	173 638	24 471	21 162
Bank deposits and cash equivalents	71 599	51 705	8 726	6 302
Total current assets	**272 386**	**225 343**	**33 198**	**27 464**
Total assets	**968 011**	**832 782**	**117 978**	**101 497**

BALANCE SHEET AT 31 DECEMBER

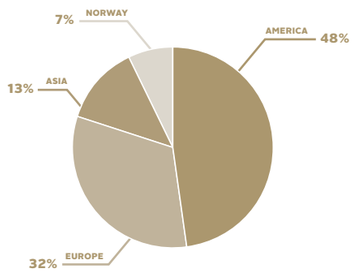
	1000 NOK	1000 NOK	Exch. rate 8,21 1000 USD	Exch. rate 8,21 1000 USD
	2017	**2016**	**2017**	**2016**
Equity and Liabilities				
Share capital	2 000	2 000	244	244
Other equity	674 930	587 014	82 258	71 543
Total equity	**676 930**	**589 014**	**82502**	**71787**
Other long-term liabilities	26 137	23 755	3 185	2 895
Other short term liabilities	264 944	220 013	32 291	26 815
Total liablities	**291 081**	**243 768**	**35 476**	**29 710**
Total equity and liablities	**968 011**	**832 782**	**117 978**	**101 497**

*Note that 2017 reflects Consolidated accounts for the KSAT Group.
Consolidated accounts were not prepared in 2016, as subsidiaries' 2016 activity were not significant for the KSAT Group.

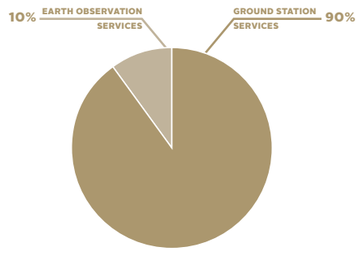
SHAREHOLDERS 31 DECEMBER 2017

Kongsberg Defence and Aerospace AS	50 %
Space Norway AS	50 %
	100 %

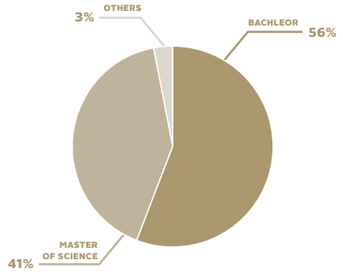
REVENUE GEOGRAPHICAL DISTRIBUTION 2017



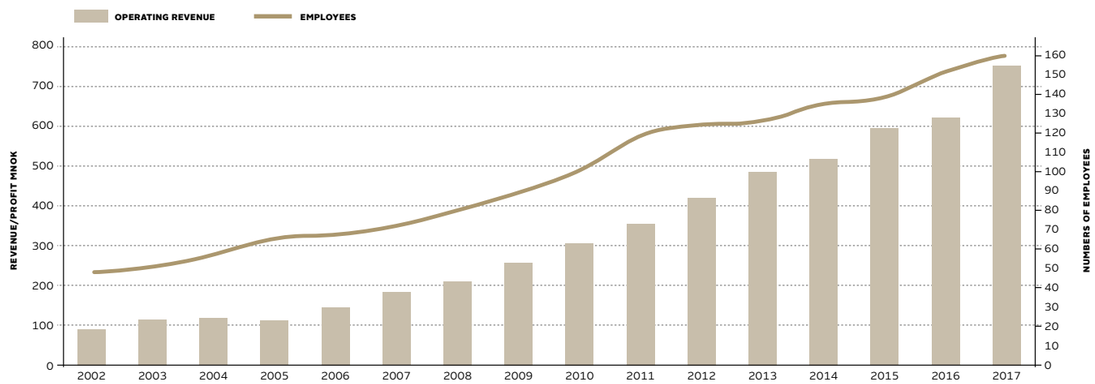
REVENUE DISTRIBUTION BUSINESS AREAS 2017



EMPLOYEES BY LEVEL OF EDUCATION 2017



KEY FIGURES



ANNUAL REPORT 2017

KSAT
KONGSBERG SATELLITE SERVICES

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