Allow me to introduce myself.
I am the small demonstration satellite 4 (SDS-4).

Fig. 1: Small demonstration satellite 4 "SDS-4" (illustration) inserted at an altitude of 677 km

What is the "SDS program" ?

In 2012, a small satellite, called "small demonstration satellite 4 (SDS-4)" , will be inserted into Earth' s orbit at an altitude of 677 km. (Fig. 1) This compact 50 cm cube with a mass of about 50 kg will contain various mission components for conducting space demonstrations.

JAXA is developing and launching various satellites, including operational satellites such as the ultrahigh-speed Internet satellite "Kizuna", which was engaged in disaster-response assistance during the Tohoku earthquake, as well as the advanced land observing satellite "Daichi" (*1) in addition to astronomical observation satellites such as the solar physics satellite "Hinode" , whose observations have led to numerous new discoveries. Since space is a harsh environment incomparable to that on the ground, the satellite components and on-board equipment must be built to withstand those conditions. In order for satellites to be more useful to society, highly functional and highly efficient satellites are continually being pursued through innovative, space-rated parts and components. However, it may be difficult, from the ground, to verify that newly developed parts and components can withstand the environment of space and operate as expected. In addition, parts and components developed through great efforts may be turned down because "there are no proven results" .

The "SDS program" (*2) resolves these issues..

*1: Operation ended on May 12, 2011.

*2 : A "program" is a collection of "projects"

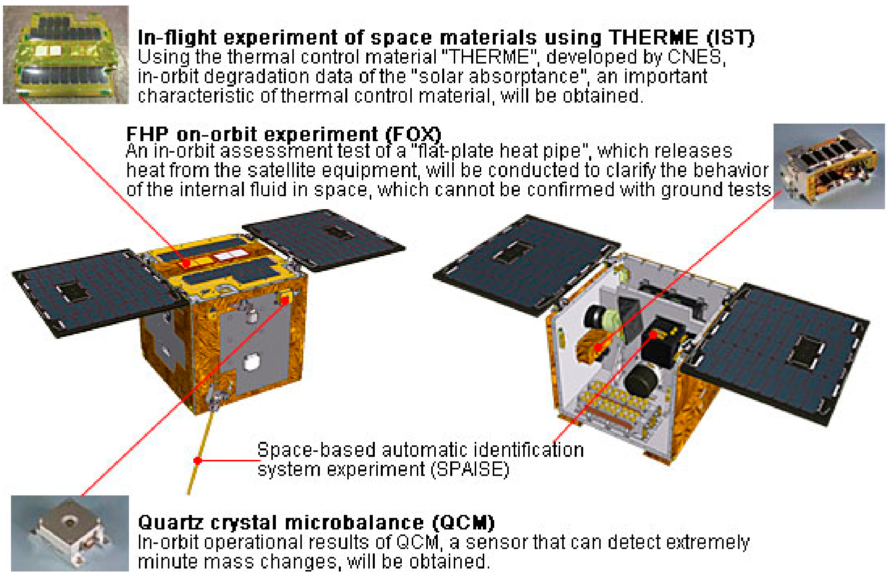


Fig. 2: Four missions of SDS-4

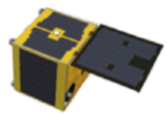
A small size is the best weapon

That is the hallmark of SDS.

Satellites are launched by launch vehicles. If the mass of the satellite is smaller than the launch capability of the launch vehicle, in other words, if there is a surplus, a small-sized satellite that fits that surplus can piggyback and be launched at the same time. SDSs capitalize on their small size and are launched as piggyback payloads. In January 2009, small demonstration satellite 1 (SDS-1) was launched as a piggyback payload of the greenhouse gases observing satellite "Ibuki" and conducted in-orbit demonstrations of new communications equipment.

Currently, development of SDS-4 is continuing as a piggyback payload of the global change observation mission 1st-water "Shizuku" to be launched in 2012. We plan to conduct four missions (in-orbit tests): "space-based automatic identification system experiment (SPAISE)", "FHP on-orbit experiment (FOX)", "in-flight experiment of space materials using THERME (IST)" and "quartz crystal microbalance (QCM)". (Fig. 2)

There is also the advantage that a small satellite can limit the development period and costs. In addition, if the manufacturing process for the satellite can be further simplified, a greater reduction of the development period and costs can be achieved. Satellites consist of the "bus system", which is the basic components, and the "mission system", which conducts the various demonstrations; the bus system can be standardized. With SDS-4, we are also focusing on "obtaining standard bus technologies for the 50-kg-class small satellite" (fig. 3).

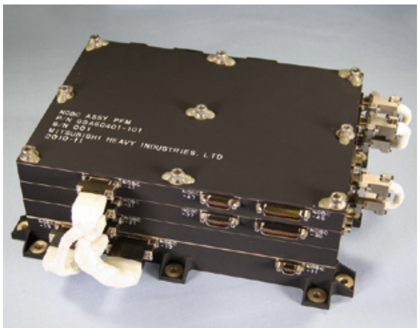
Satellite class		100 kg class, spim	100 kg class, 3-axis	50 kg class, 3-axis
Satellite size		70 x70 x 60 cm	70 x 70 x 60 cm	50 x 50 x 50 cm
Main mission example		Parts/large component demonstration	Mission concept demonstration/ sensor demonstration	Component/sensor demonstration
Orbit		Low Earth orbit (LEO)		
Attitude control method		Spin stabilization (when stationary) Three-axis bias momentum (for experiment))	Earth-/sun-oriented Three-axis zero momentum	Sun-oriented (when stationary) Three-axis zero momentum
Communication		HK：16kbps, Mission：1Mbps		
Mission resource	Mass	Approx. 40 kg	Approx. 30 kg	Approx. 6 kg
	Power	Approx. 30 W (Approx. 60 W peak)	Approx. 25 W (Approx. 60 W peak)	Approx. 15 W (Approx. 20 W peak)
	Capacity	60 x 55 x 25cm	60 x 55 x 25 cm	33 x 15 x 10 cm
External view		SDS-1 Type 		SDS-4 Type 

The SDS-4 will focus on obtaining the standard bus technologies inside the red frame.

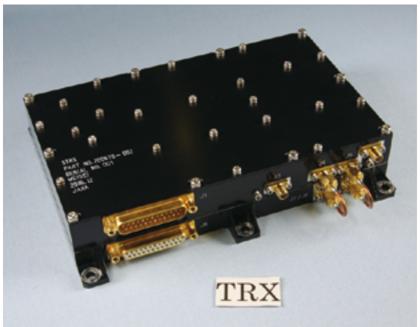
Fig. 3: Concept of SDS satellite bus

Greatly improved performance in attitude control and data processing with SDS-4

Compared with the conventional 50 to 100 kg class of small satellites, the SDS-4 is equipped with remarkably better "attitude control performance". This is thanks to attitude control software demonstrated on a newly developed "computer" (fig. 4A). Additionally, in order to send a large amount of the obtained data at high speed, the "S-band communications equipment" (fig. 4B) was also newly developed. These will allow data from the SPAISE mission to be obtained. (Fig. 5)



A: Computer

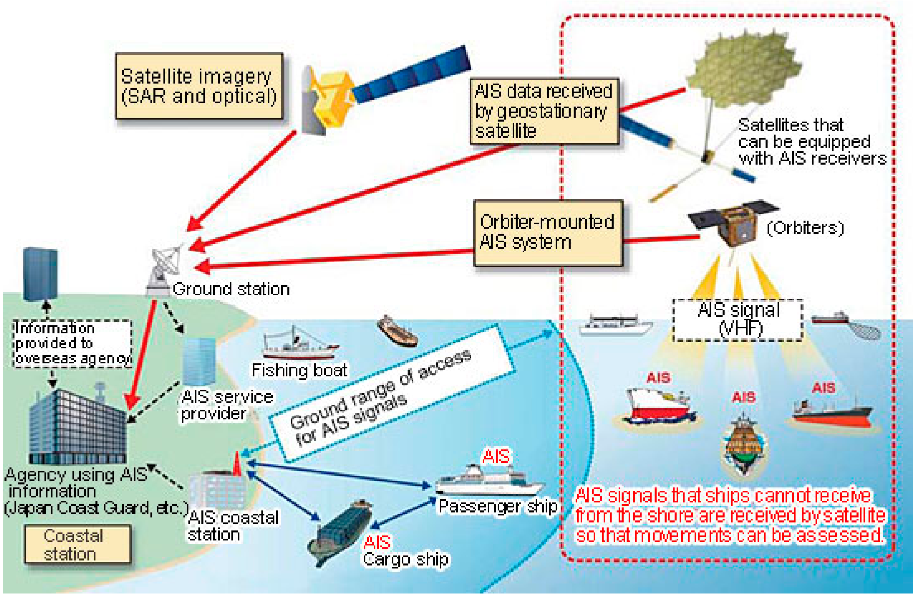


B: S-band communications equipment

Fig. 4: SDS-4 is equipped with the domestically most advanced "computer" and "S-band communications equipment" for a 50-kg-class small satellite.

The pains of childbirth, the joy of parenting

The SDS-4 program is assuming the role of "raising the young". To that end, younger staff in their first or second year at JAXA will be involved in every process of satellite



Using maritime automatic identification system (AIS) equipment, ships automatically transmit ship-specific information, such as the ship' s name and ship type, as well as trip information, such as their position or course, to nearby ships or coastal stations. If this AIS signal could be received by a satellite in orbit, information could be retrieved from ships traveling in a location, such as the Pacific Ocean, from where signals cannot be received by coastal stations. With SPAISE, we will "confirm the functional capabilities of a satellite-mounted AIS receiving system" and "assess the state of interference in the received data" . Because a vast amount of data will be obtained in orbit, newly developed S-band communications equipment makes the SPAISE mission possible since data could not downlink to the ground with conventional communications equipment for small satellites.

Fig. 5: Space-based automatic identification system experiment "SPAISE"

development.

Development of a satellite begins with the "conceptual design". During conceptual design, the mission requirements are first analyzed, and then the basic concepts and items needed to refine the design are determined, for example, what the shape of the satellite will be and what attitude it will have in orbit. When conceptual design is finished, the process enters "basic/detailed design" , where the actual object is made. During basic/detailed design, two types of prototype models, called the "electrical model" and "structural-thermal model" , are created. Using the electrical model, electrical connections and performances are confirmed and software is developed. Using the structural-thermal model, a "vibration test" (simulating vibrations at launch) and a "thermal balance test" (simulating the thermal environment of space) are conducted. If these clear all tests with no problems, manufacturing begins on the "flight model" , which will actually be launched into space. Using the flight model, various tests, such as a vibration test and a thermal vacuum test, are conducted and, if it is confirmed to fully withstand the environment of space, it will begin its journey into space. (Fig. 6) At the same time that the satellite body is being developed, research and development is also being conducted on the small satellite bus system. This bus system will be employed in the SDS project where prospects for its specifications are in sight.

Satellites are not "finished once they are created" . Immediately after the satellite is launched, there is an extremely tense situation waiting to see whether or not the radio waves emitted by the satellite can be received, in other words, whether or not the satellite can be found. The fundamental points, namely, whether the satellite can be found and its attitude stabilized as well as whether power is being correctly supplied, take two days to be confirmed (critical phase). Next, over about one month, the satellite performance is checked and tests are conducted to determine that the mission is carried out properly (commissioning phase), and the satellite transitions to its actual operation (regular phase). SDS-4 is planned to have a regular phase of about half a year. Afterward, while the satellite is still orbiting Earth in a good condition, we plan to conduct various additional tests for its final phase. In this way, the SDS-4 project members will experience the entire process from the development of the satellite to its operation.

"The satellite development is like a pregnancy and its operation is like raising a child," says Yosuke Nakamura of the Space Technology Demonstration Research Center. Until it takes the form of a satellite, a lot of effort is given for it to grow in the womb (ground), and then we experience labor pains until the delivery (launch). After the launch, we inquire on the condition every few hours like with a newborn baby (critical phase), and then it becomes independent (commissioning phase and regular phase). However, as parents, we do not take our eyes off it (final phase). In this way, Nakamura has been involved in carefully bringing up satellites as the satellite systems engineer for SDS-1 and as the project manager of SDS-4. His may be one form of nurturing young.

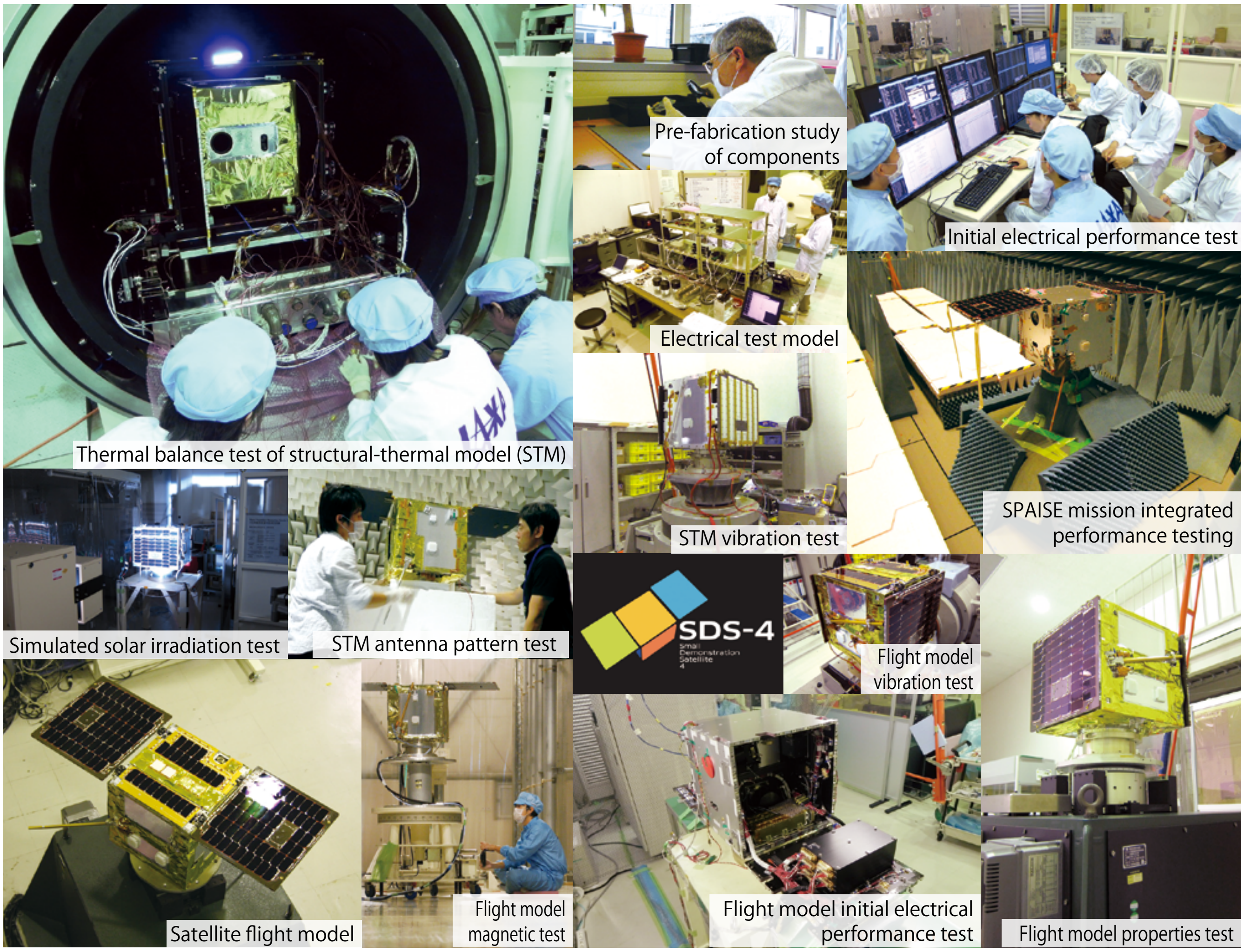


Fig. 6: Process of satellite development

[Space Technology Demonstration Research Center]

SDS-4 development members.