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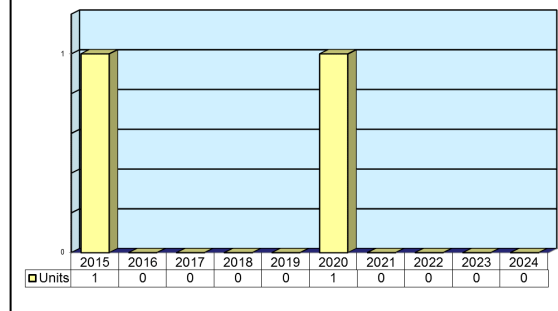
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Jason Series

Outlook

- Thales Alenia Space selected to build SWOT satellite
- NASA and CNES signed agreement to work on SWOT in June 2014
- In July 2012, NASA awarded Space Exploration Technologies a contract to launch Jason-3 aboard Falcon-9 launch vehicle

Unit Production Forecast
2015-2024



Orientation

Description. The Jason-1 was the follow-on to the TOPEX/Poseidon mission. Jason is a series of Earth observation satellites designed to measure sea surface heights. The Ocean Surface Topography Mission (Jason-2) is the successor to the Jason-1.

Sponsor. Overall policy for the Jason-1 was the responsibility of the NASA Office of Space Science and Applications. An international partnership consisting of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the French Space Agency (CNES), and U.S. agencies NASA and the National Oceanic and Atmospheric Administration (NOAA) launched and operate the Jason-2 satellite. EUMETSAT has also agreed to help NOAA and CNES fund the Jason-3 mission.

Status. The Jason-2, launched in 2008, is currently operational. The Jason-3 is in development.

Total Produced. NASA and CNES have taken delivery of the Jason-1 and Jason-2.

Application. The Jason-1 was an oceanographic satellite designed to study the surface topography and other physical characteristics of the global ocean. It mapped the circulation of the world's oceans in conjunction with major international experiments in oceanography. The Jason-2 continues these duties.

Price Range. The Jason-1 cost approximately \$12 million to produce. The Jason-2 cost about \$250 million, including launch and development. The Jason-3 is expected to cost about \$350 million to produce.

Jason Series

Contractors

Prime

Thales Alenia Space France	http://www.thalesgroup.com/en/worldwide/space , 26 ave JF Champollion, BP 1187, Toulouse, 31037 France, Tel: + 33 05 34 35 36 37, Fax: + 33 05 61 44 49 90, Prime (Proteus Satellite Bus)
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Subcontractor

RUAG Space AB	http://www.ruag.com/Space/ , Solhusgatan 11, Göteborg, 405 15 Sweden, Tel: + 46 31 735 00 00, Fax: + 46 31 735 40 00 (Data Handling Unit; S-band Antennas)
Rafael Advanced Defense Systems Ltd	http://www.rafael.co.il , PO Box 2250, Haifa, 31021 Israel, Tel: + 972 4 879 4444, Fax: + 972 4 879 4657, Email: info-mkt@rafael.co.il (Hydrazine Tank)
Thales Alenia Space Italia	http://www.thalesgroup.com/en/worldwide/space , SS Padana Superiore 290, Vimodrome, Milan, 20090 Italy, Tel: + 39 022 507 51, Fax: + 39 022 505 515 (GPS Assembly)

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Technical Data

Design Features. The Jason-1 served as an extension of the TOPEX/Poseidon mission. The Jason-1 was based on Thales Alenia Space's Proteus bus and had a total mass of 500 kilograms (1,102 lb) and twin solar panels that provided 1.0 kW of power. Reaction wheels and magnetic torque rods maintained three-axis stabilization and nadir pointing, while a hydrazine propellant system provided orbital maintenance.

Satellite communications were provided through the Wallops Ground Network Tracking Stations at Poker Flat, Alaska, and Wallops Island, Virginia. The spacecraft carried the following instruments.

- **Poseidon-2.** This instrument is an upgraded version of the Poseidon-1 used on the TOPEX/Poseidon spacecraft. It was a low-power, low-mass, solid-state altimeter that sent radar pulses at two frequencies using the C- and Ku-bands.
- **JMR.** The Jason Microwave Radiometer had three frequencies (18.7 GHz, 23.8 GHz, and 34.0 GHz)
- **TRSR.** The Turbo Rogue Space Receiver was a GPS receiver. It provided orbit determination to the Jason-1. The TRSR package included two independent single-string receivers with two omnidirectional antennas, a low-noise amplifier, a crystal oscillator, a sampling down-converter, and a baseband digital processor.
- **DORIS.** Developed by CNES, this radio tracking system (Doppler Orbitography and Radiopositioning Integrated by Satellite) provided high-precision orbit determination. The instrument comprised a receiver, ultra-stable oscillator, switch box, and omnidirectional antenna. The receiver used on the Jason-1 was a smaller version of the receiver used on the ENVISAT satellite.

Jason Series

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Bus Size	9.54 x 9.54 x 10 m	31.29 x 31.29 x 32.8 ft
Payload Module Size	9.54 x 9.54 x 12.18 m	31.29 x 31.29 x 39.95 ft
Weight		
Satellite Mass	500 kg	1,102.5 lb
Platform Mass	270 kg	595.35 lb
Payload Mass	120 kg	264.6 lb
Altimeter Mass	55 kg	121.27 lb
Performance		
Altitude	1,336 km	828.32 mi
Orbit	Circular	
Satellite Power	450 W	
Platform Power	300 W	
Payload Power	147 W	
Altimeter Power	78 W	
Storage Capacity	2 Gbits	
Downlink Capacity	650 kbps	
Pointing Accuracy	0.035°	
Mission Length	5 yr	

Variants/Upgrades

Jason-2/OSTM. The NASA/CNES follow-on to the Jason-1 – the Ocean Surface Topography Mission, also known as Jason-2 – was launched in 2008. It launched on the same orbit as the Jason-1 by flying within +/-1 kilometer of the same 9.9-day repeating track. It studies sea surface height for continued climate forecasting research and for scientific and industrial applications.

The Jason-2 carries five primary scientific instruments: a three-frequency advanced microwave radiometer provided by NASA to measure total water vapor along the altimeter path; a NASA GPS payload; a NASA-supplied laser retroreflector array, which works with ground stations to track the satellite and calibrate the other satellite location systems; a CNES Poseidon-3 nadir altimeter (C- and Ku-band) to measure heights above sea surface; and the CNES DORIS. The DORIS is a Doppler tracking antenna that receives ground signals for precise orbit determination, for satellite

tracking, and to collect ionospheric correction data for the CNES altimeter.

Jason-3. Initial preparations are underway for the Jason-3, the follow-on to the Jason-2. EUMETSAT is also working closely with NOAA, CNES, and other partners to determine the onboard instruments for the Jason-3 and establish a development framework. The Jason-3 is expected to cost about \$350 million.

Surface Water Ocean Topography. The SWOT mission will be a follow-on to the Jason-3. The SWOT satellite will include a Ka-band radar interferometer, altimeter, microwave radiometer, Doppler tracking antenna, GPS receiver, and laser retroreflector array. Data gathered by the SWOT satellite will be used to better understand the global water cycle and improve ocean circulation models. Like previous missions, the SWOT satellite will provide ocean surface height data. It will also provide information on rivers and lakes.

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Jason-2/OSTM

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Bus Size	9.54 x 9.54 x 10 m	31.29 x 31.29 x 32.8 ft
Payload Module Size	9.54 x 9.54 x 12.18 m	31.29 x 31.29 x 39.95 ft
Weight		
Satellite Mass	500 kg	1,102 lb
Platform Mass	270 kg	595 lb
Payload Mass	255 kg	561 lb
Performance		
Altitude	1,336 km	828.32 mi
Inclination	66°	
Orbit	Circular	
Mission Length	3 yr (goal of 5 yr)	
Satellite Power	450 W	
Pointing Accuracy	0.15°	

Program Review

TOPEX/Poseidon. The TOPEX/Poseidon was the first satellite to study oceanography. The joint U.S.-French satellite lifted off on August 10, 1992. It orbited Earth until it retired in October 2005 after a reaction wheel stalled.

Jason-1. The Jason-1 was launched in December 2001 from Vandenberg Air Force Base, California. April 2003 marked the beginning of the operational phase for the Jason-1. The satellite was finally decommissioned in July 2013 after the last of the spacecraft's transmitters stopped functioning.

Jason-2. In May 2004, CNES awarded a contract to Alcatel Space (now Thales Alenia Space) to build the Ocean Surface Topography Mission spacecraft, also known as Jason-2, on a satellite bus based on its Proteus platform. The contract covered the manufacture of the main instrument, the Poseidon-3 altimeter, as well as assembly, integration, and testing. The satellite bus was covered under a previous contract for five platforms that CNES had signed with Alcatel Space.

NASA Makes It Official

NASA officially joined the OSTM program in 2008. NASA provided several of the mission's science instruments, including an advanced microwave radiometer, laser retroreflector array, and GPS payload receiver package. NASA also provided launch services on a Boeing Delta II rocket. NOAA provided a satellite-control center, stations for commanding the spacecraft and acquiring data, data-processing capability, and the infrastructure for archiving and distributing mission data.

Jason-2 Launched

A Delta II rocket placed the U.S.-French Jason-2 satellite into orbit on June 20, 2008. The Delta II 7320-10 lifted off from Vandenberg Air Force Base in California and placed the Jason-2 in a sun-synchronous, low-Earth orbit 55 minutes later.

EUMETSAT On Board for Jason-3 Funding

Jason-3. In June 2007, at a meeting of the EUMETSAT Council in Cork, Ireland, a decision was made to agree in principle to share the costs of the Jason-3 satellite with NOAA and CNES. The mission will cost about \$350 million and is expected to launch in 2015 to continue the work of the Jason-2/OSTM satellite. NOAA will provide the launch vehicle for the Jason-3, and CNES will provide the Thales Alenia-built Proteus satellite platform.

In June 2009, EUMETSAT nations agreed to spend EUR63.6 million (\$81.5 million) on the Jason-3. At that time, the members of EUMETSAT agreed to make formal financial commitments in December; however, formal commitment did not come until February 2010 due to work-share issues.

In July 2012, NASA awarded Space Exploration Technologies (SpaceX) a contract to carry the Jason-3 into orbit aboard a Falcon-9. The launch will take place from Vandenberg Air Force Base in California. The launch contract is worth \$82 million.

Jason Series

Surface Water Ocean Topography. NASA and CNES signed an agreement in May 2014 to cooperate on the SWOT mission. Initial studies into the mission began in 2009. Preliminary design activities are expected to be complete in 2016, with a launch planned for 2020. Although the Jason name will continue with the European Space Agency's Sentinel-6 program, the SWOT mission is considered a closer successor to previous Jason missions since it is funded by the U.S. and France rather than ESA.

Under the agreement, NASA will provide the payload module, radar interferometer, radiometer, laser retroreflector array, and GPS receiver. It will also support the satellite's launch. CNES will provide the spacecraft bus, radar frequency unit, altimeter, Doppler tracking antenna, satellite command and control system, and data-processing infrastructure. CNES selected Thales Alenia Space to build the spacecraft bus.

Funding

NOAA and NASA in the U.S. and EUMETSAT and CNES in Europe jointly fund the Jason program.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Dec	2001	Jason-1 launches on Delta II
Sep	2003	TOPEX/Poseidon decommissioned, replaced by Jason-1
Jun	2008	Jason-2 launches on Delta II
Jun	2014	NASA and CNES agree to cooperate on SWOT mission
Jan	2015	Thales Alenia Space selected to build SWOT satellite

Forecast Rationale

Partners working on the Jason-3 satellite expect a launch to take place in late 2015. The launch of the satellite is a continuation of the previous Jason Series satellites. In order to maintain continuity with the Jason-1 and Jason-2, planners would like to launch the Jason-3 before the Jason-2 reaches the end of its service life. This will allow time for researchers to cross-check the data from the Jason-2 and Jason-3 in order to minimize calibration errors between the two satellites' data sets.

Although preparation continues on the Jason-3, NASA and CNES have begun planning for a follow-on mission to maintain continuity. In June 2014, the two agencies signed an agreement to cooperate on the Surface Water Ocean Topography (SWOT) mission. Thales Alenia

Space was selected to build the platform in January 2015. Work is expected to be complete in time for a launch in 2020. Although there will continue to be a Jason mission, dubbed Jason-CS, it will be part of the European Space Agency's Copernicus program.

The successor to the Jason-3 will be the SWOT mission, since it will continue ocean surface height measurements for the U.S. and France. At one point, ESA considered joining the joint-U.S./France program. However, since work share was largely divided between the U.S. and France, ESA decided to pursue its own ocean surface height mission. The U.S. and France will use the SWOT mission to continue a collaboration that started with the TOPEX/POSEIDON mission and continued through the Jason Series satellites.

Jason Series

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		High Confidence				Good Confidence			Speculative			
	Thru 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Thales Alenia Space France												
Jason-3												
	0	1	0	0	0	0	0	0	0	0	0	1
Surface Water and Ocean Topography (SWOT)												
	0	0	0	0	0	0	1	0	0	0	0	1
Subtotal	0	1	0	0	0	0	1	0	0	0	0	2
Total	0	1	0	0	0	0	1	0	0	0	0	2