European ATV

Outlook

- ATV-5, the last ATV produced – launched on July 30, 2014
- ESA will use experience gained with ATV to provide components to NASA's Orion MPCV
- ATV-4, named Albert Einstein, launched on June 5, 2013
- ATV-3, named Edoardo Amaldi, launched on March 23, 2012

Orientation

Description. The European Automated Transfer Vehicle (ATV) is a space cargo transfer vehicle that launches on board an Ariane 5 and carries supplies to the International Space Station (ISS).

Sponsor. The European Space Agency, to fulfill its obligation to support the International Space Station.

Status. The first European ATV was launched in 2009. The contract included four additional spacecraft.

Total Produced. The first European ATV, called the Jules Verne, was launched in 2009. The second spacecraft, called the Johannes Kepler, was launched in February 2011. The third ATV, the Edoardo Amaldi, launched in March 2012. The fourth ATV, the Albert Einstein, launched on June 5, 2013. The fifth ATV, Georges Lemaitre, launched on July 30, 2014.

Application. The European ATV carries dry cargo, atmospheric gas, water, propellant, and equipment used for experiments to the ISS crew. It is then reloaded with trash and waste products from the ISS, which are incinerated during re-entry into Earth's atmosphere.

Price Range. ESA spent $1.1 billion to develop the ATV and build the Jules Verne, and another $1 billion to purchase four additional ATVs. A single ATV mission is estimated to cost EUR425 million ($585 million), including launch and operations.

Contractors

Prime

Astrium GmbH (EADS)	http://www.astrium.eads.net, Hünefeldstrasse 1-5, PO Box 286156, Bremen, 28361 Germany, Tel: + 49 421 539 5885, Fax: + 49 421 539 5782, Prime (Propulsion Module)

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Subcontractor

Astrium Satellites (EADS)	http://www.astrium.eads.net/en, 31, Ave des Cosmonautes, ZI du Palays, Toulouse, 31402 France, Tel: + 33 5 62 19 62 19, Fax: + 33 5 61 54 57 10 (Avionics Module)
Thales Alenia Space Italia - Roma	http://www.thalesgroup.com/Markets/Space/Home/, Via Saccomuro, 24, Rome, 00131 Italy, Tel: + 39 06 41511, Fax: + 39 06 4190675 (Integrated Cargo Carrier)

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Services/Governments & Industries) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

	Metric	U.S.
Dimensions		
Length	10.7 m	35.1 ft
Diameter	4.5 m	14.8 ft
Span across solar arrays	22.3 m	73.2 ft
Launch mass	20,750 kg	45,746 lb
Cargo upload capacity	7,667 kg	16,903 lb
Performance		
Engine thrust	1,960 N	441 lbf
Orbital life	6 months	6 months
Cargo Load		
Dry cargo	5,500 kg	12,125 lb
Water	855 kg	1,885 lb
Air (O^2N^2)	102 kg	225 lb
Refueling propellant	860 kg	1,896 lb
Reboost propellant	4,700 kg	10,362 lb
Waste capacity	6,300 kg	13,889 lb

The European Automated Transfer Vehicle is a logistical supply spacecraft designed to dock with the International Space Station to deliver supplies. The ATV carries dry cargo, food, water, air, and propellant. Once the ATV is unloaded, the station crew loads waste onto the vehicle. The ATV then descends to Earth and incinerates in the atmosphere. The ATV is launched on an Ariane 5.

A control center will observe the ATV and control it when necessary. However, the ATV automatically navigates to and docks with the space station.

While docked, the ATV can use its thrusters to reposition the space station. This can be done in an emergency or to correct normal degradation of the space station's orbit.

The ATV is composed of two main modules – the service module and the pressurized cargo module, also known as the Integrated Cargo Carrier.

The ATV Service Module, which is not pressurized, includes propulsion systems, electrical power, computers, communications, and most of the avionics.

The avionics, designed and built by Astrium (now Airbus Defence and Space), provide the onboard computers, the attitude and navigation sensors, the communications subsystem between the ATV and the ISS ground control centers, and the onboard power generation and distribution systems.

The ATV propulsion system, designed and built by Astrium, provides the spaceship with the orbit transfer capability and the ISS re-boost support. ATV uses four main engines plus 28 smaller thrusters for attitude control. All valves and thrusters are controlled by four control units connected to the main ATV computers.

The Integrated Cargo Carrier, developed and built by Thales Alenia, contains the re-supply payload up to 7,667 kilograms (16,903 lb). Ninety percent of the carrier is pressurized, and 10 percent is non-pressurized. Liquids are carried in the non-pressurized part and are transferred to the space station through dedicated pipes. The pressurized section is 48 cubic meters and has room for up to eight standard racks that can carry solid cargo.

The pressurized section allows the space station crew to unload supplies directly into the space station. It also

allows the crew to use the ATV as an extra living space while it is docked. While Jules Verne, the first ATV, was docked with the ISS, crews used it as sleeping quarters and as a hygiene station.

Variants/Upgrades

ESA is working to develop a modified Integrated Cargo Carrier, called the Advanced Re-Entry Vehicle (ARV), which could return to Earth without incinerating. Such a vehicle would allow ESA to bring equipment and completed experiments back to Earth. ESA would eventually like these vehicles to also have the ability to launch humans into space and return them back to Earth.

Computer-Generated Image of the Jules Verne Headed to the ISS

Source: ESA

Program Review

The European Space Agency began development of the European Automated Transfer Vehicle to fulfill its obligations to support the International Space Station. With the ability to transport 7,667 kilograms (16,903 lb) into space, the ATV is an important part of the effort to continue space station operations. That importance increased with the cancellation of the United States Space Shuttle program. While many countries are participating in the ISS re-supply effort, the ATV is one of the largest transports.

The ATV was originally scheduled to be completed in 2003, with a launch date planned for the fall of 2004. However, cost overruns, technical issues, and changing requirements forced continual delays in the program.

In April 2004, ESA renegotiated the contract with prime contractor Astrium Space Transportation of Bremen. Up until that point, the ATV was being developed under a cost-reimbursement contract. However, in an effort to control costs, ESA signed a $1.1 billion fixed-fee contract. Any cost overruns from that point on would be paid for by industry.

In October 2005, ESA signed an additional EUR835 million ($1 billion) contract with Astrium to build six ATVs in addition to the one built under the test program. This number was reduced from an originally planned eight ATVs because the spacecraft can carry a larger payload than originally planned. By the end of 2005, it became clear that the first ATV would not be launched until at least the middle of 2007.

In December 2006, the total number of flights of the ATV was cut from seven to five, including the first flight by the Jules Verne. ESA believed the five flights would be enough to carry the 20,000 kilograms of supplies needed to be transported to the ISS.

In July 2009, ESA awarded Astrium a EUR21 million ($29.8 million) contract to conduct a feasibility study on a manned spacecraft. The spacecraft will likely be based on the ATV. Development could cost more than the

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EUR1.35 billion ($1.8 billion) it cost to develop the ATV.

ATV-1. Thermal vacuum tests were successfully completed on the first ATV – dubbed Jules Verne by ESA – in December 2006. These tests were the last of 17 main functional system tests and followed the successful completion of a number of other tests, including vibration tests, simulations of docking hardware and software, tests of data and power transfer between the ATV and ISS, and trials of the transfer of gases, fuel, and liquids.

Long-Awaited Launch Occurs

Even with the ATV's successful tests, the launch of the Jules Verne was delayed. By February 2008, ESA announced that the Jules Verne had been encapsulated in its fairing on top of an Ariane 5 launch vehicle. The launch finally took place on March 9, 2008. This marked the launch of one of the largest and most complex spacecraft by ESA.

The ATV docked with the ISS on April 4, 2008. The space station crew entered the vehicle the next day and began unloading supplies. While the ATV was docked with the ISS, it fulfilled a number of missions besides station re-supply. On April 25, the ATV boosted the orbit of the station. The station suffers from a normal degradation of its orbit, and boosting its orbit is routinely required. Later, in August, the ATV conducted a debris-avoidance maneuver. Space debris is a problem for the space station, and vessels docked with the station are required to change their orbit from time to time to avoid the debris.

Since the ATV is pressurized, the crew was also able to use the vessel as additional living space while it was docked. After a six-month mission, the ATV undocked from the space station on September 5, 2009; the Jules Verne headed back to Earth carrying waste from the station and then burned up in the Earth's atmosphere.

ATV-2. The launch of ATV-2, the Johannes Kepler, was expected to take place at the end of 2010. Problems early in 2010 delayed Ariane 5 launches, however, limiting launches for the year to six rather than the planned seven. The conflicts delayed the Johannes Kepler's launch until February 2011.

ATV-3. ESA announced in March 2010 that the third ATV was to be named the Edoardo Amaldi. Delivery of the ATV-3 was announced in August 2011, and it was launched on board an Ariane 5 on March 23, 2012. ATV-3 docked with the ISS on March 29. Its mission was completed on October 4, 2012, when it re-entered the atmosphere.

ATV-4. In August 2011, Astrium announced that ATV-4 had reached the integration stage. ESA had already revealed the name of the spacecraft in May of that year: the Albert Einstein. In August 2012, ATV-4 left Astrium's manufacturing plant in Bremen, Germany, on its way to Kourou to be prepared for launch. An Ariane 5 carried ATV-4 to the ISS on June 5, 2013. Its mission ended on November 2, 2013, when it re-entered the atmosphere.

ATV-5. ATV-5 was the last European ATV built and launched. It is named the Georges Lemaitre, after the Belgian physicist who proposed the Big Bang Theory. The ATV-5 launched on July 30, 2014.

Orion. In January 2013, ESA agreed to provide NASA with a service module for NASA's Orion spacecraft. The service module will be based on components from the ATV. The contribution is worth an estimated EUR455 million ($625.8 million), and will cover ESA's financial obligation to the International Space Station effort for the years 2018 through 2020.

The first ESA-provided service module will equip an Orion spacecraft for an expected 2017 launch. ESA will likely continue to supply service modules after that date.

Funding

The ATV was funded by ESA as part of its obligation to support the International Space Station. In April 2004, ESA signed a EUR975 million ($1.1 billion) fixed-fee contract to develop the ATV and build the Jules Verne. In October 2005, ESA signed a EUR835 million ($1 billion) contract to purchase additional ATVs; ESA originally planned to purchase six ATVs, but the agency ultimately purchased four ATVs under this contract.

Contracts/Orders & Options

Contractor	Award ($ Millions)	Date/Description
Astrium	1,100.0	Apr 2004 – Fixed-fee contract to develop the ATV and purchase one vehicle.
Astrium	1,000.0	Oct 2005 – Contract to purchase four additional ATVs.

Timetable

Month	Year	Major Development
Apr	2004	Fixed-fee contract signed to develop ATV
Oct	2005	Contract signed to build additional ATVs
Jan	2007	Thermal vacuum testing on the Jules Verne completed
Mar	2008	Launch of first ATV, the Jules Verne
Apr	2008	The Jules Verne docks with International Space Station
Sep	2008	The Jules Verne undocks with ISS and burns up in Earth's atmosphere
Feb	2009	Second ATV named the Johannes Kepler
Mar	2010	Third ATV named the Edoardo Amaldi
Feb	2011	Launch of ATV-2, the Johannes Kepler
May	2011	Fourth ATV named the Albert Einstein
Jun	2011	The Johannes Kepler undocks with ISS and burns up in Earth's atmosphere
Mar	2012	Launch of ATV-3, the Edoardo Amaldi
Jan	2013	ESA and NASA agree that ESA will contribute ATV components to NASA's Orion program
Jun	2013	Launch of ATV-4, the Albert Einstein
Jul	2014	Launch of ATV-5, the Georges Lemaître

Worldwide Distribution/Inventories

The ATV was built for ESA as part of its obligations to support the International Space Station.

Forecast Rationale

With the launch of the ATV-5 mission in 2014, production of the ATV has ended. The ATV was the European Space Agency's (ESA's) primary contribution to the International Space Station. For this reason, it was once expected that ATV production would continue throughout the life of the ISS. However, European leaders are firm in their desire to contribute to the space station in other ways.

ESA members debated the merits of two plans that could fulfill ESA's contribution to the ISS effort. The first plan, proposed by Germany, called for ESA to contribute components to NASA's Orion Multi-Purpose Crew Vehicle (MPCV). A competing plan, proposed by France and Italy, would have ESA develop and build a multipurpose vehicle that could be used for a variety of tasks, including transporting supplies to the space station and servicing in-orbit satellites. Germany's plan was ultimately selected.

Under this strategy, ESA will contribute components worth approximately EUR455 million ($625.8 million) to NASA for its Orion spacecraft. The components will cover ESA's planned financial contribution to the ISS for 2018 through 2020.

With this decision, the Georges Lemaitre became the fifth and final ATV to be produced; it launched in July 2014. Following the 2014 launch of ATV-5, ISS resupply duties will fall to the Russian Progress, Japanese HTV, SpaceX Dragon, and Orbital Sciences Cygnus.