STATUS OF NASA’S COMMERCIAL CARGO AND CREW TRANSPORTATION INITIATIVE

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Abstract

To stimulate the commercial space transportation industry, the National Aeronautics and Space Administration (NASA) is facilitating the demonstration of Commercial Orbital Transportation Services (COTS) to Low Earth Orbit (LEO) by private-sector companies. In 2006, NASA entered into funded agreements with two such companies to share NASA’s $500 million investment, SpaceX and Rocketplane Kistler (RpK), each of which proposed to obtain the additional private financing needed to complete its flight demonstrations. In 2007, NASA terminated the agreement with RpK because it failed to meet a series of technical and financial milestones which were necessary to receive the incremental NASA payments. In 2008, NASA conducted another competition for the remaining $170 million of NASA funding and entered into a funded agreement with Orbital Sciences Corporation (OSC). This paper provides an overview of the COTS approach of SpaceX and OSC and the status of their efforts to develop reliable and cost-effective commercial transportation to serve the LEO marketplace.

Background

As NASA marks its 50th anniversary, it is completing the assembly of the International Space Station (ISS) and is focusing on exploring the solar system and beyond. The Space Shuttle is required for ISS assembly. To free up resources for exploration, the United States plans to retire the Shuttle after ISS assembly is complete and use commercial space transportation to service the ISS. This was directed by the President in January 2004:

“Pursue commercial opportunities for providing transportation and other services supporting the International Space Station and exploration missions beyond low Earth orbit.”

The NASA Administrator in 2005 discussed the benefits of this direction:

“I believe that, with the advent of the ISS, there will exist for the first time a strong, identifiable market for routine transportation service to and from LEO, and that this will be the first step in what will be a huge opportunity for truly commercial space enterprise.”

To implement this initiative, NASA in 2005 created the Commercial Crew & Cargo Program with these objectives:
• Implement U.S. Space Exploration policy with investments to stimulate the commercial space industry,

• Facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities with the goal of achieving reliable, cost-effective access to LEO, and

• Create a market environment in which commercial space transportation services are available to Government and private sector customers.

The Program defined two phases of COTS:

• Phase 1 – Development and demonstration by private industry of space transportation capabilities to and from LEO. NASA has a role similar to a lead investor. Space Act Agreements (SAAs) are used in lieu of traditional cost contracts.

• Phase 2 – Purchase of commercial transportation services to and from ISS. NASA is a customer. Traditional commercial services contracts are used.

In January 2006, NASA began COTS Phase 1 by requesting proposals from industry to develop and demonstrate any or all of the following capabilities:

• Capability A – Deliver external (unpressurized) cargo to a LEO test bed and safely dispose of external cargo.

• Capability B – Deliver internal (pressurized) cargo to a LEO test bed and safely dispose of internal cargo.

• Capability C – Deliver internal (pressurized) cargo to a LEO test bed and safely return internal cargo to Earth.

• Capability D – Deliver crew to a LEO test bed and safely return crew to Earth.

NASA announced that it would provide up to 500,000,000 USD to fund demonstration of Capabilities A, B, and C over the period of 2006 through 2010. Capability D was an option requiring additional funds if exercised. Payments would be made by NASA only upon the successful completion of negotiated performance milestones.

In August 2006, NASA announced that Space Exploration Technologies (SpaceX) and Rocketplane Kistler (RpK) would receive funded SAAs for COTS Phase 1 to develop and demonstrate all capabilities, including the option for Capability D. Each company was required to contribute non-NASA funds to the development and demonstration program. The SAA thus included financial performance milestones.

After initial progress, RpK was unsuccessful in raising the non-NASA funding necessary to execute its program. As a result, it missed several milestones and its SAA was terminated by NASA in September 2007.

NASA announced a recompetition for the remaining funds in October 2007. In February 2008, NASA announced selection of Orbital Sciences Corp. as its new partner for a funded SAA. Orbital committed to providing the necessary non-NASA resources from internal corporate funds.
SpaceX COTS Approach

SpaceX is an entrepreneurial space company which is developing a family of launch vehicles based on the Falcon 1 and Falcon 9. For COTS, SpaceX is developing the Dragon spacecraft for launch on the Falcon 9. This system addresses all four COTS capabilities. The SpaceX COTS program is summarized in Figure 1.

Merlin, an engine designed and produced by SpaceX, is used across the Falcon family. It uses liquid oxygen and kerosene and is regeneratively cooled. Nine Merlin engines are used on the Falcon 9 first stage and one is used on the second stage. The Dragon spacecraft consists of a pressurized capsule and unpressurized trunk.

This design provides flexibility in transporting pressurized cargo, unpressurized cargo, and/or crew. Although its funded cargo demonstration flights will have no crew, SpaceX is designing Dragon and Falcon 9 to be human rated. Flight hardware is recoverable and eventually intended to be refurbished and reused.

In the past year, SpaceX has made solid progress, meeting all of its COTS milestones. SpaceX recently conducted a simultaneous test firing of 5 engines and has begun work on its launch site at Cape Canaveral, Florida.
Orbital Sciences COTS Approach

Orbital Sciences is an established aerospace company which has developed a number of launch vehicles, including Pegasus, Minotaur and Taurus. Its COTS system consists of the new Taurus II launch vehicle and Cygnus spacecraft. This system addresses COTS capabilities A and B. The Orbital Sciences COTS program is summarized in Figure 2.

The Taurus II first stage uses two liquid oxygen and kerosene Aerojet AJ26-62 engines. The second stage uses one ATK Castor-30 solid motor. Cygnus consists of Pressurized and Unpressurized Cargo Modules (one per mission) and a common Service Module.

Since receiving the funded COTS award from NASA, Orbital Sciences has completed key preparatory milestones, namely a Taurus II preliminary design review, program plan review, and system requirements review. Orbital plans to launch its COTS demonstration from the Wallops Flight Facility in Virginia.

Figure 2 – Orbital Sciences COTS Overview
COTS Demonstration Schedule

Depicted in Figure 3 are the planned dates of COTS flight demonstrations by the two funded partners. SpaceX is planning on three demonstration launches, with the third planned to go to ISS in March 2010. Orbital Sciences is planning on one demonstration launch, which is scheduled to visit ISS in December 2010.

Figure 3 – COTS Flight Demonstration Schedule

Unfunded Partners

In 2007, NASA entered into unfunded Space Act Agreements with five companies:

- Transformational Space (t/Space)
- PlanetSpace
- Constellation Services International (CSI)
- SpaceDev
- SPACEHAB

The purpose of these agreements is to exchange technical information to facilitate private-sector development of transportation systems to LEO. All of these developments rely completely on private financing.

Recent efforts by the unfunded partners include completion by PlanetSpace of its first five milestones and preparation by SpaceDev for test firings of its hybrid engine. SPACEHAB terminated its space transportation SAA but continues to work with NASA to stimulate LEO markets. CSI announced plans to focus on the microgravity market and has also terminated its SAA with NASA.
ISS Commercial Resupply Services Procurement

In April 2008, NASA began COTS Phase 2 by issuing a request for proposals (RFP) for Commercial Resupply Services for the ISS.

In issuing the RFP, NASA stated its intention to award task orders to fulfill the annual ISS resupply demand requirements for the years 2010 through 2015 concurrent with award of the basic contract(s). Minimum orders of 20,000 kg upmass and 3,000 kg downmass are anticipated for each contract awarded.

NASA plans to announce the winner(s) of the competition in November 2008.

Related Activities of the Commercial Crew & Cargo Program

The Commercial Crew & Cargo Program works with each funded and unfunded partner to facilitate the development of planned space transportation systems. It also works on developing the “ecosystem” necessary for the emerging COTS industry to flourish.

Ecosystem development activities include educating the investment community about NASA’s commitment to COTS, facilitating the development of voluntary COTS industry standards, and working with the Federal Aviation Administration which has responsibility to license COTS launch and reentry operations. The Program convenes a LEO Working Group of transportation and LEO destination providers to facilitate cooperation and information exchange.

A focus of these efforts is to stimulate markets for COTS beyond ISS resupply. If COTS has sufficient non-NASA customers to increase flight rate, economies of scale should result in lower prices. That would benefit NASA and other customers and encourage still greater demand.

One potential market which could be large but needs development is applied microgravity research in LEO. The biotechnology and other industries could benefit from microgravity. However they are generally unaware that regular commercial transportation to and from LEO will soon be available and that a robust, capable ISS will be open for business. The Program is striving to develop this market by educating these industries.

COTS offers a new way of doing business when government mission needs intersect with commercial markets. For example, NASA is considering cooperation with commercial industry and international partners to develop a lunar communications network. The Commercial Crew & Cargo Program is working to promote consideration of industry partnerships across NASA, sharing lessons learned and building on the momentum of COTS.

Conclusion

NASA’s COTS initiative has been very successful to date, with two funded partners on track for cargo transportation demonstrations to ISS in 2010, the timeframe of Space Shuttle retirement. NASA has begun procuring commercial transportation services for the predictable logistics needs of ISS. If successful, these efforts will extend...
human presence in space by enabling an expanding and robust U.S. commercial space transportation industry which can serve ISS and stimulate other markets in LEO.

References


