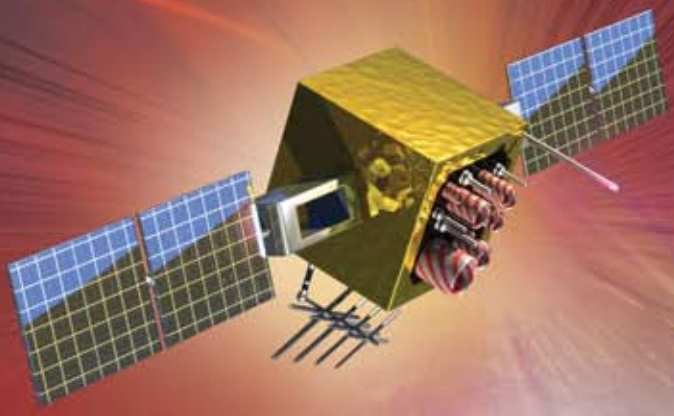
Federal Aviation Administration

Support Services for Commercial Space Transportation

October 2008



About the Office of Commercial Space Transportation

The Federal Aviation Administration, Office of Commercial Space Transportation, licenses and regulates U.S. commercial space launch and reentry activity as well as the operation of nonfederal launch and reentry sites as authorized by Executive Order 12465 and Title 49 United States Code, Subtitle IX, Chapter 701 (formerly the Commercial Space Launch Act). The Office's mission is to ensure public health and safety and the safety of property while protecting the national security and foreign policy interests of the United States during commercial launch and reentry operations. In addition, the Office is directed to encourage, promote, and facilitate commercial space launches and reentries. Additional information concerning commercial space transportation can be found at http://ast.faa.gov.

Available from

Federal Aviation Administration
Associate Administrator for Commercial Space Transportation
800 Independence Avenue, S.W., Rm. 331
Washington, D.C. 20591
http://ast.faa.gov

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Introduction

Space transportation operators interact with a range of organizations that provide services to enable safe and successful transportation activities. New space transportation markets, such as re-supply of space stations and commercial human spaceflight, could drive demand for improved or new support services. This study provides a review of organizations that supply space services in an attempt to understand what services are available in a number of specific categories. Interviews with a number of but not all commercial orbital and suborbital transportation operators help identify any new or improved services that are needed. This study is only a snapshot and is not intended to include all space transportation support service categories or providers. The study focuses primarily on U.S. based service providers but also includes a few notable international providers.

The categories of support services examined within this study include:

- Communications
- Surveillance
- Space Traffic Control
- Navigation
- Meteorology
- Space Weather
- Orbital Servicing
- Crew Rescue
- Technician Training

Other essential support services discussed in separate FAA/AST reports including :

- Human Spaceflight Training
- Spaceports

The "Commercial Human Spaceflight Training Survey" released by FAA/AST in February 2008 discusses available human spaceflight training support services. AST's annual "2008 U.S. Commercial Space Transportation Developments and Concepts: Vehicles, Technologies, and Spaceports."

Why Undertake This Study?

AWARENESS

A large number of government and commercial organizations provide support services critical to the commercial space transportation industry within the United States. As demand for space transportation services increases it is important to identify the support services necessary to enable the growth of a healthy commercial space transportation industry. Government and public awareness of the role that these organizations play will help foster increased support for these support services.

PLANNING

Space transportation operators and government users need to understand what services are available in order to develop and field space transportation systems. The user community can also employ this study and the resulting discussions to voice feedback about support services. In addition, service providers can use this study to understand more thoroughly the needs of the user community and as a result improve their service offerings.

How is this Study Organized?

This study was generated through primary research with the support service providers and interviews with select suborbital and orbital space transportation operators.

The first section of the study consists of an introductory discussion of the services available and the services needed for each of the support service categories. Some sections also include feedback from commercial space transportation operators.

The second section consists of more detailed profiles of the support service providers. Each profile examines the following questions:

- Contact information
  - How can the reader access more information about the service provider?
- Summary of services
  - What high level services does this organization provide?
- Background and development plans
  - What is the basic background of this organization?
  - What facilities and equipment does the organization own or have access to?
  - Does the organization have plans to further develop the services offered? (e.g., deploy new infrastructure, offer new services, etc.)
- Accessibility
  - Are the services available to commercial operators?
  - How can commercial operators access the services?
  - Are there access fees associated with the services?

Although the profiles contain a large amount of information, readers should contact the organizations for full details about the services. In addition, services provided by spaceports vary and should be contacted individually.

What Support Services are Available and What Services are Needed?

COMMUNICATIONS

A number of methods exist for providing communications between space transportation vehicles and ground systems and controllers. Suborbital space transportation operators, especially those who launch and land at the same facilities, should be able to use in-house or local ground-based systems to provide communication services. Orbital transportation systems circle the globe every hour and a half and require multiple communication access points for transportation vehicles to remain in continuous contact with the ground. During the beginning of the space age the Soviet Union and the United States deployed large and costly land- and sea-based communication networks around the planet in order to communicate with launch vehicles and spacecraft. Today's orbital space transportation operators have a number of terrestrial- and space-based options including private and public land-based facilities, national space-based systems, such as the Tracking and Data Relay Satellite System (TDRSS), and commercial space-based networks such as ORBCOMM, Iridium, and Globalstar.

Communications Services Needed

Space transportation operator feedback indicated that TDRSS is very useful but it wasn't developed for commercial use and the cost of using TDRSS services is relatively expensive. Land-based communications networks are available but are also rather expensive. LEO networks are affordable but offer limited bandwidth. GEO satellite communications systems offer greater bandwidth but require bulky transceiver equipment. An affordable, high-bandwidth space-based communications capability was identified as a very useful service that is not currently provided.

Most land-based systems focus on providing communication services to satellites and other spacecraft that operate in a given orbit for a long duration of time and are not optimized for the relatively short duration of most space transportation activities. However, some ground systems that support spaceports and associated national ranges provide limited communications support during launch to facilitate range safety.

TDRSS is the premier civil government space-based communications system that is used to provide the majority of communication services to government space transportation systems. Commercial space-based networks that exist primarily to serve terrestrial communications needs can also be used by commercial space transportation operators. Low Earth orbit (LEO) systems, including ORBCOMM, Iridium, and Globalstar, can provide useful service at affordable rates with limited bandwidth. Geosynchronous Earth orbit (GEO)-based communications satellites may be able to offer greater bandwidth but require larger transceivers to be carried on the transportation vehicle.

SURVEILLANCE

Space surveillance refers to the ability to detect, track, and identify objects in space. Space Surveillance services in use by space transportation operators include calculation of debris-clear launch trajectories and in-orbit debris tracking and

collision warnings. Space surveillance systems use various types of sensors including electro-optical, conventional and phased-array radars. The primary supplier of space surveillance capability within the United States is the Space Surveillance Network, which consists of a world-wide network 29 sensors that provide data on 24,500 cataloged objects in space. The Joint Space Operations Center (JSpOC) within the U.S. Strategic Command provides collision avoidance analysis for the Space Shuttle and International Space Station. During NASA missions the JSpOC computes possible close approaches of other orbiting objects with the Space Shuttle or ISS. JSpOC also conducts re-entry assessments for objects including prediction of time, location of atmospheric reentry, and potential ground impact.

Surveillance Services Needed

Operator feedback indicated that existing surveillance services were adequate for the space launch phase. In-orbit surveillance of objects that could collide with commercial space transportation systems was identified as a useful service.

A program was begun by the DoD in 2003 called the Commercial & Foreign Entities Support Pilot Program (CFE). The CFE program transferred surveillance data sharing responsibilities from NASA to the DoD. CFE implemented an online database dubbed "Space Track" that allows approved and registered entities to access surveillance data free of charge. The CFE program currently offers analytical support including basic conjunction (conflicting orbital trajectories) services. In the future, CFE may offer more advanced analytical services including pre-launch safety screenings and end of life/reentry support. A number of separate space surveillance capabilities, operated by foreign governments, exist throughout the world. The provider profiles offer more detailed information about space surveillance systems.

Space Traffic Control Services Needed

Suborbital operator feedback indicated that the process of receiving authority to transit airspace above 60,000 feet is slow. A more responsive approach would help suborbital operators complete multiple ad-hoc flights to space in a single day. Orbital operator feedback indicated that space debris is a great concern for sustained orbital space transportation operations. Orbital operator feedback indicated that space system disposal standards are useful for controlling space debris.

SPACE TRAFFIC CONTROL

Space traffic control services within the United States consist of an assortment of decentralized processes. A variety of organizations exert control over specific space activities. A space transportation operator needs to coordinate the development and launch of a space transportation system with the FAA. Radio spectrum usage will need to be coordinated with the FCC, who will also share info with the ITU. U.S. federal government operators will coordinate radio spectrum usage with the National Telecommunications and Information Administration (NTIA).

Spaceports provide launch support services including access to airspace within which to conduct a space launch. Commercial space transportation systems passing through the national airspace system must coordinate and receive approval with the controlling authority, which may include the FAA and the U.S. Department of Defense. Spaceport profiles are not included in this section but

spaceports, especially those located within national ranges, may exert control during the space launch phase. Once in orbit, rendezvous with space stations or satellites requires coordination with the controlling entity. For example, rendezvous with the International Space Station (ISS) would require coordination with ISS mission control. Reentry at the end of the mission requires coordination with the FAA. A number of standards exist that aim to reduce orbital debris by specifying how space systems should be disposed of at the end of useful life.

NAVIGATION

Space transportation operators may utilize navigation services provided by a number of space-based navigation systems. Space based navigation systems are currently used primarily to navigate spacecraft in orbit, however, space based navigation systems can also be used to track launch vehicle position during ascent into space. Global Positioning System (GPS)-based launch range systems have been tested successfully and could reduce the need for radars and other expensive launch range infrastructure.

Most space vehicles using space-based navigation systems use the Global Positioning System (GPS). GPS is a U.S.-built and -operated space-based radio-positioning system that provides users with worldwide positioning, navigation, and timing services. It consists of a constellation of between 24 and 32 satellites in medium Earth orbit.

The Russian GLONASS system is the next most well developed positioning system that consists of approximately 19-24 operational satellites. China is planning to deploy the Compass positioning system but has only deployed four satellites so far. European countries are funding the development of the Galileo positioning system. Two test satellites have been launched and the system is scheduled to be operational in 2013.

Navigation Services Needed

Operators cited the usefulness of GPS for position, navigation, and timing information for their transportation systems. One orbital operator believes that the national ranges contain expensive range equipment which in part results in high operational costs. GPS-based range systems could enable the use of lower-cost spaceports or reduce range infrastructure.

METEOROLOGY

Space launch and reentry require accurate forecasting and real-time monitoring of weather conditions. Scheduling and preparation for a space transportation launch can be impacted by forecasted weather conditions. The launch itself may be restricted by factors such as temperature, visibility, and high altitude winds. Once space transportation systems are safely in orbit, the operations of ground-based support systems such as communications relays, radars, or other mission critical systems can experience interference with by weather. For transportation systems that return to Earth, weather must also be considered when planning and executing reentry and landing procedures. Space transportation operators and the spaceports that support them may have varying requirements regarding the type and accuracy of atmospheric weather information; however, weather services play a critical role in supporting commercial space transportation.

The National Weather Service (NWS) within the United States collects and disseminates weather data and products through a number of sources including the Internet. Current NWS and privately-generated aviation weather services may be adequate for some space transportation operators. However, specialized weather services are available at a number of launch ranges within the United States. At Cape Canaveral, a number of meteorological entities exist within the USAF, NASA, NWS, and private contractors. The United States Air Force operates specialized weather squadrons, the 45th at Patrick Air Force Base and the 30th at Vandenberg Air Force Base, in support of space launch. Space transportation companies launching from federal ranges rely on the range to provide meteorology information. The Eastern and western ranges rely on customized weather monitoring systems to support space launch activities. The Eastern range uses the Eastern Range Dispersion Assessment System and the Western range uses the Meteorological Interactive Data Display System-Vandenberg. For specific information about range capabilities contact VAFB at (805)605-7206 and CCAFS at (321)494-4803.

Meteorology Services Needed

No weather service deficiencies were identified by the spaceflight operators interviewed.

The NOAA National Weather Services Spaceflight Meteorology Group supports NASA's human spaceflight program with meteorology and weather forecasting services that support human spaceflight. The Applied Meteorology Unit at Cape Canaveral tests advanced weather prediction and monitoring technologies and serves as a bridge between meteorological researchers and the operational forecasters within the USAF, NASA, and the NWS.

SPACE WEATHER

Space weather describes the short-term impact on the Earth's magnetosphere from the Sun's photons, solar wind particles, and the interplanetary magnetic field. The impacts of concern are the adverse affects on technological systems, such as telecommunications, power distribution, and navigation. The health of humans in space may also be impacted by severe space weather events. The primary components of space weather are solar flares, sunspots, solar winds, and coronal mass ejections (CMEs).

Space weather information is collected and analyzed by a variety of academic and government programs. Some of these organizations study space weather as part of a mission to advance scientific knowledge or to support tools used for educating students about the space environment. Such services are provided by the entities like the High Altitude Observatory (HAO) or the Center for Space Environment Modeling (CSEM). However, several organizations serve as focal points for more timely distribution of space weather data and products that can be used by space transportation operators to support their operations.

Within the United States, the Space Weather Prediction Center (SWPC), jointly operated by NOAA and the USAF, is the country's official source for space

weather information. SWPC information is accessible via a number of sources including the Internet. The SWPC continually monitors and forecasts Earth's space environment, provides solar-terrestrial information, conducts and leads research and development programs to understand the enviro-nment and to improve services, and advises policy makers and planners.

Within Europe, the Space Environments and Effects Section is the European Space Agency's (ESA's) focal point for analyses of the physical environment in space and its effects on space systems and astronauts. The Section is also the driving force behind the ESA Space Weather applications initiative, which has led to the online tool called The Space Weather European Network (SWENET), a series of applications, services, and data products that enable registered users access to data and services on space weather and environment and its effects. SWENET collects data through several external sources, including the SWPC, and makes it available through a common database.

On a more global scale, the International Space Environment Service (ISES), is a service group operating under the support of the International Union of Radio Science. ISES is one of twelve such service groups, created by the Federation of Astronomical and Geophysical Data Analysis Services, which are dedicated to the study of astronomy, geophysics and related sciences. The specific mission of ISES is to facilitate near-real-time international monitoring and prediction of the space environment. They are able to accomplish this using a network of eleven Regional Warning Centers throughout the world, which collectively monitor and predict solar-terrestrial activity. They also assist users who wish to mitigate the impact of space weather on activities that could be sensitive to solar-terrestrial conditions.

Space Weather Services Needed

Mission controllers and flight crews need access to up-to-the-minute updates on solar activity. Some operator confusion exists on whether critical space weather information distribution is quick enough to be operationally useful. For example, a suborbital spaceflight that rises above the Earth's atmosphere for a short period during an solar event may experience an increased risk of single event upsets within electronics or expose crews to medically significant levels of radiation. Orbital space transportation systems will be exposed for longer periods of time to the effects of solar activity making it critical for operators to know solar conditions. A representative of SWPC indicated that solar data is available to operators in a timely manner.

ORBITAL SERVICING

In-orbit servicing is a forward-looking support service that could include resupplying, refueling, and repairing space transportation systems in orbit. Like crew rescue, servicing services could be provided by the space transportation organizations and used by them as well. For example, the NASA Commercial Orbital Transportation Services (COTS) program is funding the development of a limited commercial in-orbit servicing capability. Future space transportation architectures that extend to geostationary orbits, and on to the Moon and Mars, may include fuel depots that transportation providers may service and be

Orbital Servicing Services Needed

Operators did not identify any further requirements.

serviced by. Repair or upgrading of satellites or damaged transportation infrastructure could be accomplished by such a service.

A number of in-orbit servicing systems have existed for awhile now. For example, the Space Shuttle was initially conceived as a system that would not only carry astronauts into space but also rendezvous and repair, refuel, and generally service the United States space infrastructure. Indeed, the Space Shuttle has been used in this capacity a number of times, most notably to repair the Hubble Space Telescope. Russia's Progress spacecraft has supplied Russian space stations and the International Space Station for a long time. Most recently the European Space Agency-developed Automated Transfer Vehicle (ATV) has successfully demonstrated a large capacity servicing mission to the International Space Station.

Advanced servicing technologies and capabilities have been developed and tested in programs such as Orbital Express. In this mission, a prototype servicing satellite rendezvoused with another test satellite and exchanged fuel and equipment through the use of robotic interfaces. Complimentary research includes the Front-end Robotics Enabling Near-term Demonstration (FREND), a DARPA sponsored technology risk reduction program. FREND is a ground-based demonstration of robotic technologies that could be used to accomplish autonomous rendezvous and grapple with a variety of interfaces.

A number of commercial organizations have proposed space servicing concepts including fuel depots. However, no operational services, beyond those national systems identified earlier, yet exist. No detailed profiles were developed as a result.

IN-ORBIT CREW RESCUE

In-orbit crew rescue is a forward-looking support service that commercial space transportation operators may themselves offer. In the future it may be efficient for one organization, perhaps government funded, to have a rescue vehicle on-call that could support the majority of manned space activity at the time.

In-orbit Crew Rescue Services Needed

Operators did not identify any further requirements.

Today, emergency rescue plans for space flight crews and participants are specific to the particular space vehicles and space programs in operation. As a result, there is no "generic" rescue vehicle or program that can be called upon to rendezvous and dock with a new commercial spacecraft. Unless multiple issues are resolved (such as standardization of docking mechanisms and hatches), a commercial space operator may need to consider appropriate redundancies and docking capabilities within their own fleet so as to conduct their own rescue missions should the need occur. The only current in-orbit crew rescue systems are operated by government agencies involved with ISS, Soyuz, and Space Shuttle activity. Current strategies include "lifeboat" Soyuz vehicles attached to the ISS, backup Space Shuttle launches, and compatible interface mechanisms.

TECHNICIAN TRAINING

Training of technical personnel to support the space transportation industry has occurred primarily by the space transportation companies themselves. Each organization developed its own training curricula tailored to its needs. No national certification similar to what the FAA offers for aircraft maintenance personnel existed until recently. The National Science Foundation funded the development of a standardized process for training aerospace technicians. When hiring new personnel, organizations can better understand the knowledge and skills of candidates with the certification. SpaceTEC is the organizing force behind the certification and as a result a number of colleges and other organizations are offering this new aerospace technician certification.

Technician Training Services Needed

Space transportation operator feedback indicated that spaceflight technician training is specialized because space transportation systems employ differing technologies and architectures. Therefore an FAA-mandated technician certification, similar to aviation technician, does not make sense.

Summary of Service Providers

A number of providers of support services for commercial space transportation were profiled during this study. Although the profiles contain a large amount of detailed information, readers should contact the organizations for full details about the services. The following table summarizes the organizations and systems profiled:

Support Service	Provider Systems and Organizations
Communications	NASA Tracking and Data Relay Satellite System NASA Deep Space Network Iridium Satellite LLC Orbcomm Globalstar
Surveillance	Space Surveillance Network Other International Space Surveillance Programs
Space Traffic Control	FAA Office of Commercial Space Transportation Federal Communications Commission International Telecommunication Union National Telecommunications and Information Administration
Navigation	Global Positioning System Other International Navigation Programs
Meteorology	NOAA NWS Spaceflight Meteorology Group
Space Weather	NOAA Space Weather Prediction Center European Space Agency - Space Environments and Effects Section The International Space Environment Service
Crew Rescue	Russian Federal Space Agency National Aeronautics and Space Administration
Technician Training	SpaceTEC

Communications Profiles

NASA TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS)

Contact Information:
Networks Integration Management Office
NASA Goddard Space Flight Center
Greenbelt, MD 20771
Email: scott.a.greatorex@nasa.gov

SUMMARY OF SERVICES

TDRSS operates as a bent pipe relay system between customer space platforms and customer ground facilities and offers the following services:

- Telecommunications
- Tracking
  - Tracking and data acquisition services between low Earth orbiting (LEO) spacecraft and NASA/customer control and/or data processing
  - Tracking and clock calibration services provide the following measurements for multiple access service (MA), S-Band Single Access Service (SSA), and Ku-band Single Access (KuSA), as well as SSA/MA cross-support customers:
    - Range
    - Doppler
    - Customer Time
    - Return Channel Time Delay (RCTD)
- Testing
- Analysis
- Data Distribution/Processing Services

BACKGROUND AND DEVELOPMENT PLANS

TDRSS is part of NASA's Space Network (SN), which was established in the early 1980s to replace NASA's network of ground tracking stations that had supported all of NASA's manned flight missions. It consists of nine on-orbit satellites located in geosynchronous (GEO) orbit and ground stations used for space communications. The system's goal is to increase the time spacecraft are in communications with the ground network and to increase the amount of data being transferred. The operation of the SN is managed by the Goddard Space Flight Center under direction from the NASA Headquarters Space Operations Management Directorate.

The TDRSS space segment consists of six first-generation operational satellites in GEO orbit, which carry functionally identical payloads, and

three second-generation satellites, which also have identical payloads. The system's ground segments are located near Las Cruces, New Mexico, and consisting of two functionally identical ground terminals known as the White Sands Complex and the Guam Remote Ground Terminal.

Between 2005 and 2007, NASA worked on developing the low-cost TDRSS transceiver (LCT2) for use by launch vehicles to relay telemetry through TDRSS to the ground. The goal of the LCT2 development was to cut the transceiver cost in half, to about US$75,000 per unit. LCT2 would also eliminate the expense of having multiple ground stations downrange tracking the launch. At the end of development, NASA planned to transfer the technology over to the industry, particularly to commercial rockets and inexpensive sounding rockets such as those that fly routinely at Wallops Flight Facility in Virginia. In March 2007, LCT2 launched aboard an orbital piggy-back payload on a Minotaur 1 rocket.

ACCESSIBILITY OF SERVICES

Services on TDRSS are being managed by the Space Communications and Navigation Program Office at NASA Headquarters. The Space Network Project at GSFC, handles day-to-day operations of TDRSS and SN. Customer interface and requirements development are handled by the Network Integration Management Office (NIMO) at GSFC. TDRSS services may be available to both commercial and civilian customers on a reimbursable basis for missions in which NASA has a particular interest by providing forward service command data to payloads and return service data to scientists and operations personnel. TDRSS customers include:

- ATV space tug
- International Space Station (ISS)
- Space Shuttle
- Hubble Space Telescope (HST)
- Landsat 7
- Sea Launch
- South Pole TDRSS Relay (SPTR)
- NASA's Earth Observing System EOS: TERRA, AQUA, AURA
- Tropical Rainfall Measuring Mission (TRMM)
- The Rossi X-ray Timing Explorer (RXTE)

NASA DEEP SPACE NETWORK (DSN)

Contact Information:
NASA Jet Propulsion Laboratory (JPL)
4800 Oak Grove Drive
Pasadena, CA 91109
http://deepspace.jpl.nasa.gov/dsn/index.html

SUMMARY OF SERVICES

The DSN provides the following services through its network of antennas and two-way communications link:

- Transmit commands to distant spacecraft
- Receive telemetry data from spacecraft
- Track the position and speed of spacecraft
- Receive science data from spacecraft
- Measure variations in radio waves for radio science experiments
- Perform very-long-baseline interferometry observations
- Monitor and control the performance of network

BACKGROUND AND DEVELOPMENT PLANS

The DSN was established in 1958 after the first U.S. satellite, Explorer 1, was launched and when the operations of its designer and builder, Jet Propulsion Laboratory (JPL), were transferred from the U.S. Army to NASA. It was created back then to track Explorer 1 in space and to provide communications for all deep space missions. The DSN is an international network of antennas that supports interplanetary spacecraft missions, radio and radar astronomy observations for exploration of the solar system and the universe, and selected Earth-orbiting missions. The Interplanetary Network Directorate (IND) is the branch within NASA JPL that manages the DSN program.

The DSN consists of three deep space communications complexes situated in semi-mountainous, bowl-shaped terrain and are located approximately 120 degrees of longitude apart in the following areas:

- Goldstone, in California's Mojave Desert
- Near Madrid, Spain
- Near Canberra, Australia

Each complex has at least four receiving and transmitting stations equipped with ultra-sensitive receivers and large parabolic dish antennas that are steerable and high-gain.

- Stations are operated remotely from a central signal processing center at each site.

- Central signal processing centers have electronic systems that point and control the antennas, receive and process telemetry data, transmit commands, and generate spacecraft navigation data.

The DSN's future depends on NASA's continuous exploration of the solar system and beyond with both robotic and human-piloted spacecraft, which may require expanded and high data rate deep space communications. An array of new smaller DSN antennas with combined collecting area ten times larger than the existing 70-meter antennas is one of the possibilities. Using laser light to communicate is another possibility, as well as having optical communications terminals on Earth or in orbit to improve data collection.

ACCESSIBILITY OF SERVICES

The coordination for the use of the DSN facilities is arranged with the Telecommunications and Mission Operations Directorate within JPL. There have been no reports of DSN providing services to the commercial sector. Most of its missions are commissioned by NASA. DSN supports an average of 35 to 40 deep space missions each year. As a mission is being developed, a representative from the DSN program works with the mission team to establish the amount of coverage the mission will need from DSN assets during its lifetime. This coverage includes the amount of time per day for routine communications and also critical coverage of major mission events. Once the amount of coverage time is established and major mission events are scheduled, DSN commits to providing coverage for 95 percent of the time agreed to with its mission customers, while the remaining five percent allows for unexpected disruptions during that coverage.

IRIDIUM SATELLITE LLC

Contact Information:
6707 Democracy Boulevard, Suite 300
Bethesda, MD 20817
(301)571-6200 Fax: (301)571-6250
www.iridium.com

SUMMARY OF SERVICES

Iridium provides satellite voice and data communications services through dedicated handsets and installed communications systems onboard ships, aircraft, land-based handsets and value added voice and data products.

- Maritime
  - Ship Safety and Alert System (SSAS)
  - Crew Calling
  - In Network – Iridium phones installed on vessels and headquarters
  - Long Range Identification and Tracking (LRIT) Transceiver
  - The Iridium Fax Service

  - Vessel Monitoring System (VMS)
  - Man Overboard
  - Broadband Mobile Data (New Service)
- Aviation
  - Cockpit -Flight communications, tracking, monitoring, alerts and alarm
  - Flight Tracking
  - Rotary Wing Aircraft solutions
  - Air Safety Services
- Land/Mobile
  - Prepaid/Postpaid Solutions
  - Asset Tracking
  - Fleet Management
  - Oil and Gas Telemetry
  - Disaster Emergency/rescue operations
- DoD
  - Over-the Horizon
  - Netted
  - Blue Force Tracking
  - Unattended Sensors

BACKGROUND AND DEVELOPMENT PLANS

The company started out as Iridium Inc. in 1991 and began its commercial operations in 1998. It then filed Chapter 11 bankruptcy in 1999. In December 2000, a group of private investors led by Dan Colussy acquired the operating assets of the bankrupt Iridium, and formed Iridium Satellite LLC. The acquired assets included the satellite constellation, the terrestrial network, Iridium real property, and intellectual capital.

Iridium provides satellite voice and data communications via its constellation of 66 LEO satellites. The company has operations centers in Tempe, Arizona and Leesburg, Virginia, and a gateway in Hawaii for DoD services. The company is planning major investments for launching its Iridium NEXT system, a next generation 66-satellite constellation, which will be fully operational by 2016.

In 2002, Iridium participated in a joint project with Kennedy Space Center (KSC) and Wallops Flight Facility (WFF) to investigate the feasibility of using the Iridium satellite system through its Flight Modem to provide low-rate full duplex two-way communications (GPS tracking data and commands). The Flight Modem system consists of a GPS receiver, an on-board computer, and a standard commercial satellite modem, and antenna. The target applications for this project were manned and unmanned aircraft tracking and commanding and two-way backup communications system for rockets.

ACCESSIBILITY OF SERVICES

Iridium's customers come from industries, such as maritime, aviation, U.S. government/military, emergency/humanitarian services, mining, forestry, oil and gas, heavy equipment, transportation, utilities, and other foreign civil and government agencies. The company designs, builds, and sells its products, solutions, and services through its network of more than 150 distribution partners.

Contact Iridium for pricing information.

ORBCOMM

Contact Information:
2115 Linwood Avenue, Suite 100
Fort Lee, NJ 07024
1.800.ORBCOMM (703)433-6300 Fax: (703)433-6400
www.orbcomm.com/

SUMMARY OF SERVICES

ORBCOMM provides the following machine-to-machine (M2M) services for mobile and fixed site data applications:

- Monitoring and controlling assets at remote sites for oil and gas extraction, pipeline operations, storage, custody transfer, and electric power generation and distribution
- Tracking and managing construction equipment, locomotives, rail cars, trucks, trailers, shipping containers, marine vessels, aircraft, and locating and recovering stolen vehicles and cargo
- Messaging for truck fleets, owner operators, and remote workers
- Weather data for general aviation and marine vessels

BACKGROUND AND DEVELOPMENT PLANS

ORBCOMM was founded in 1993 by Orbital Sciences and Teleglobe. In November 2006, ORBCOMM issued a public offering of stock and sold 9.23 million shares of common stock. As of December 2007, ORBCOMM had 96 full-time employees, 27 located in its Fort Lee, New Jersey headquarters and 69 in its Dulles, Virginia network control center and offices.

Its ground segment consists of the following:

- Gateway Earth Stations (GES) in Argentina, Arizona, Australia, Brazil, Curacao, Italy, Japan, Kazakhstan, Korea, Malaysia, Morocco, New York, and Washington

- Gateway Control Centers (GCC) in Brazil, Italy, Japan, Korea, Malaysia, and United States
- Network Control Center (NCC) in Dulles, Virginia

In May 2008, ORBCOMM signed a $117-million contract with Sierra Nevada Corporation for the design, manufacture, and delivery of 18 new satellites, with an option to purchase as many as 30 more. ORBCOMM plans to launch the 18 satellites in three separate missions of six satellites each between 2010 and 2011.

In June 2008, ORBCOMM launched six new satellites, one Coast Guard demonstration satellite and five QuickLaunch satellites to replenish existing satellites and to expand the messaging capacity. These satellites are equipped with Automatic Identification System (AIS) payloads to receive and report AIS transmissions to be used for ship tracking and other navigational activities. ORBCOMM works with the U.S. Coast Guard on the AIS project, and also intends to market AIS data to other U.S. and international government agencies, as well as to companies whose businesses require such information.

ACCESSIBILITY OF SERVICES

ORBCOMM serves commercial and government customers through its network of 145 value added resellers (VARs) that provide whole product solutions and customer support to end-users. Service costs are based on quantity of data sent and frequency of messaging. Contact ORBCOMM for pricing information.

GLOBALSTAR

Contact Information:
461 So. Milpitas Blvd., Suite 2
Milpitas, CA 95035
(408)933-4000 Fax: (408)933-4100
www.globalstar.com

SUMMARY OF SERVICES

Globalstar offers the following satellite services designed to work with mobile phones, data terminals and accessories designed by QUALCOMM, Axonn LLC and other manufacturers:

- Mobile voice and data satellite communications
- Fixed voice and data satellite communications in rural villages, remote industrial, commercial and residential sites, and on ships
- Satellite data modem duplex and simplex services
- Personal asset tracking and remote monitoring – sending data from assets in remote locations to a central monitoring station

BACKGROUND AND DEVELOPMENT PLANS

Globalstar was formed in 1991 by a technology partnership between Loral Space and Communications and Qualcomm Inc. (QUALCOMM). On February 2002, Globalstar and three of its subsidiaries filed for Chapter 11 protection. The first stage of a two-step Globalstar's acquisition by Thermo Capital Partners LLC was completed on December 5, 2003 and the second stage was completed on April 14, 2004. On November 1, 2006, Globalstar once again became a publicly-traded company on the NASDAQ market. As of September 30, 2008, Globalstar had approximately 400 full-time employees in the U.S. and overseas .

Globalstar's satellite network includes 48 in-orbit operational LEO satellites, plus in-orbit spares. Its ground infrastructure includes two Satellite Operations Control Centers (SOCC), a Ground Operations Control Center (GOCC), a Globalstar Data Network (GDN), and a network of 25 gateways located in North America, Europe, Central America, South America and Asia. Twelve of the gateways are owned by Globalstar's subsidiaries and the rest by unaffiliated independent gateway operators.

Globalstar worked in 2001 with Wallops Flight Facility to develop a Flight Modem that will use Globalstar's satellite communications system to enable rockets or any flight vehicle to communicate with ground controllers. This space-bound Globalstar modem was a modified version of the Supervisory Control and Data Acquisition (SCADA) modem offered by Globalstar for industrial data applications such as wireless remote asset tracking and relaying telemetry information from remote sites. The Flight Modem, located aboard the rocket, acts like a Globalstar phone and places calls through the Globalstar orbiting satellites to the ground controllers. The modem can provide rocket position and may also provide information on the performance and health of the vehicle and its payload.

Globalstar has undergone the following developments pertaining to its planned second-generation satellite constellation:

- On November 30, 2006, Globalstar contracted with Thales Alenia Space to construct 48 low Earth orbit satellites.
- In March 2007, Globalstar contracted with Thales Alenia Space for the construction of the Satellite Operations Control Centers, Telemetry Command Units and In Orbit Test Equipment.
- On September 5, 2007, Globalstar contracted with Arianespace to launch its second-generation satellites. Arianespace will initially perform four Soyuz launches of six satellites each. Globalstar holds an option for four additional launches. The first launch is scheduled for September 2009.
- On May 19, 2008, Globalstar contracted with Hughes Network systems to develop a proprietary satellite air interface and manufacture the next-generation ground network equipment and software upgrades for Globalstar's gateways. Hughes will also design and manufacture ASICs for the next generation of Globalstar phones.

ACCESSIBILITY OF SERVICES

Globalstar sells its telephone products and services globally through a network of agents and resellers. It sells its data products through value added resellers in its North American, Central and South American and Western European markets Its 10 independent gateway operators distribute directly or through agents and resellers in their markets. In November 2007 Globalstar introduced its SPoT Satellite Personal Tracker which combines a GPS receiver with a Globalstar simplex transmitter. SPoT is sold on the Internet and through retail distributors of outdoor and electronic products. The company's largest market segments are the government (including federal, state, and local agencies), public safety and disaster relief, recreation and personal, and maritime and fishing. Globalstar also serves customers from telecommunications, oil and gas, natural resources (mining and forestry), and construction and utilities sectors.

Contact Globalstar for pricing information.

Surveillance Profiles

SPACE SURVEILLANCE NETWORK (SSN)

Contact Information:
U.S. Strategic Command
Joint Functional Component Command for Space (JFCC-SPACE)
901 SAC BLVD STE 1A1
OFFUTT AFB, NE 68113-6020
(402) 294-4130 (DSN prefix 271) Fax: (402) 294-4892
E-mail: pa@stratcom.mil

SUMMARY OF SERVICES

The SSN provides the following services:

- Analyze new space launches and evaluate orbital insertion
- Detect new man-made objects in space
- Chart present position of space objects and plot their anticipated orbital paths
- Produce and maintain current orbital data of man-made space objects in a space catalog
- Inform NASA and other government entities if objects may interfere with the orbits of the Space Shuttle, the International Space Station, and operational satellite platforms
- Predict when and where a decaying space object will re-enter the Earth's atmosphere
- Generate and disseminate a report on decaying debris so the event is not mistaken/misinterpreted as an attack
- Determine which country owns a re-entering space object

- Predict surface impacts of re-entering objects and notify the Federal Emergency Management Agency and Public Safety Canada if an object may make landfall in North America or Hawaii

BACKGROUND AND DEVELOPMENT PLANS

The Space Surveillance Network (SSN) has been tracking space objects since 1957 and was previously under the direction of the United States Space Command (USSPACECOM). USSPACECOM was formed to institutionalize the use of outer space by the United States. However, n October 2002, the DoD merged USSPACECOM with the United States Strategic Command (USSTRATCOM) and responsibility of the space surveillance mission fell to the newly defined USSTRATCOM mission.

The SSN consists of 29 electro-optical and radar sensors (both military and civilian) that detect, track, and identify Earth orbiting objects. Identified objects and their orbits are maintained in the Space Catalog, a comprehensive listing of the numbers, types, and orbits of about 24,500 objects in space. The 614th Air and Space Operations Center (AOC) located at Vandenberg AFB, CA is the processing facility for the SSNs flow of information. The 614 AOC employs large computers to process SSN information for various space surveillance and space control missions.

A major component of the SSN is the Space Fence, a multi-static VHF-band radar system that detects orbital objects passing over the US in Low Earth Orbit (LEO) and Medium Earth Orbit (MEO). The Space Fence is comprised of nine facilities:

- Three transmitter sites located in Lake Kickapoo, Texas; Gila River, Arizona; and Jordan Lake, Alabama
- Six receiving stations in San Diego, California; Elephant Butte, New Mexico; Red River, Arkansas; Silver Lake, Mississippi; Hawkinsville, Georgia; and Tattnall, Georgia

In April 2007, the U.S. Air Force tasked its Electronic Systems Center (ESC) at Hanscom Air Force Base to upgrade the Space Fence system by switching its radars from using VHF-band frequency to S-band. This will enable the Space Fence to detect much smaller objects in LEO and MEO to meet warfighter requirements for space situational awareness. A Request for Information (RFI) was released in May 2007 to gain industry feedback and suggestions that would improve the Space Fence's performance requirements in the areas of object detection, fence integrity, and radar coverage. Initial Operating Capability is expected in 2015. The contract award is set for January 9, 2009.

The Space Based Space Surveillance (SBSS) program plans to deploy optical sensing satellites to search, detect, and track small objects in orbit, particularly within geostationary orbit. The SBSS Block 10 will be launched in 2009. Subsequent SBSS efforts may be able to provide surveillance of even smaller objects.

ACCESSIBILITY OF SERVICES

USSTRATCOM provides space surveillance services primarily to the US military, NASA, International Space Station, other US government agencies such as FEMA, and international government agencies such as Public Safety Canada. In 2003, Public Law 108-136 transferred the responsibility for space surveillance support of commercial and foreign entities to AFSPC from NASA.

OTHER INTERNATIONAL SPACE SURVEILLANCE PROGRAMS

A number of foreign countries operate space surveillance programs. Known space surveillance capabilities are in development or operation in Russia, Germany, France, and Canada. Russia's space surveillance system is controlled by the Military Space Forces (VKS), which is a branch of the Armed Forces of the Russian Federation responsible for military space operations. VKS maintains a significant space surveillance capability independent of its Ballistic Missile Early Warning (BMEW) assets.

Germany's Forschungsgesellschaft für Angewandte Naturwissenschaften (FGAN – Research Establishment for Applied Science) Institute for High Frequency Physics and Radar Techniques controls the world's largest radome with a diameter of 49 meters. It houses the space observation radar Tracking and Imaging Radar (TIRA). The TIRA system serves as the central facility for developing and investigating radar techniques for the detection and reconnaissance of objects in space and air targets.

The French Armament Procurement Agency/ Systems Evaluation and Test Directorate (DGA/DCE) of the French Ministry of Defense operates the Armor radar sensor. ARMOR is located on the tracking ship Monge, which mainly supports French ballistic missile tests. ARMOR tracking data and orbit determinations have similar application as Germany's TIRA radar, that supports risk object re-entry and conjunction event predictions.

Established in the 1990s, the Grande Reseau Adapte a la Veille Spatial (GRAVES) experimental surveillance system is owned by the France's Department of Defense and is operated by the Office National d'Etudes et Recherches Aérospatiales (ONERA), the French Aerospace lab. The system has tracked and recorded a total of 2,500 space objects found in LEO orbits. The GRAVES system is based on VHF transmitters with planar phased-array antennas, which are located in Dijon.

In 2006, the Canadian Forces' Surveillance of Space (SofS) project was established to foster bilateral defense agreements with the US. The CF SofS Concept Demonstrator (CD), a ground-based space surveillance sensor, would contribute data to the US Space Surveillance Network (SSN).

Space Traffic Control Profiles

FEDERAL AVIATION ADMINISTRATION

Contact Information:
The Federal Aviation Administration's Office of Commercial Space Transportation (FAA/AST)
800 Independence Avenue, SW
Washington, DC 20591
(202) 267-7793
www.faa.gov/about/office_org/headquarters_offices/ast/

SUMMARY OF SERVICES

- License spaceports
- License commercial space launch
- License commercial space reentry
- Issue safety approvals
- Issue experimental permits
- Provide requirements and guidelines for commercial human spaceflight crew and spaceflight participants
- Encourage, facilitate, and promote U.S. commercial space transportation

BACKGROUND AND DEVELOPMENT PLANS

The Federal Aviation Administration's Office of Commercial Space Transportation (AST) has the authority to regulate and promote the United States commercial space transportation industry. The office was established in 1984 as a standalone entity within the Department of Transportation but was eventually transferred under the authority of the FAA in 1995. As a regulatory entity, AST ensures that commercial space transportation does not harm public health and safety, safety of property, and national security and foreign policy interests of the United States. AST's website contains a large number of reports and analysis of the past, current, and the developing commercial space transportation industry.

AST's approximately 60 employees are based primarily at the FAA headquarters building in Washington DC. AST has access to FAA equipment and personnel at a number of locations including the Volpe National Transportation Systems Center in Massachusetts and the Civil Aerospace Medical Institute in Oklahoma.

AST is working in coordination with other FAA offices to develop the Space and Air Traffic Management (SATM). SATM is not conceived as a system separate from the current National Airspace System (NAS). Instead SATM is a concept that integrates space vehicles into NAS operations while equitably sharing the airspace with conventional air traffic.

ACCESSIBILITY OF SERVICES

There are no fees to obtain an FAA/AST license or permit.

FEDERAL COMMUNICATIONS COMMISSION

Contact Information:
Federal Communications Commission (FCC)
445 12th Street SW
Washington, DC 20554
1-888-CALL-FCC (1-888-225-5322)
fccinfo@fcc.gov
www.fcc.gov/

SUMMARY OF RELEVANT SERVICES

- Regulate spectrum use of the U.S. commercial space industry
- Coordinate spectrum use of U.S. commercial space industry with national and international organizations

BACKGROUND AND DEVELOPMENT PLANS

The Federal Communications Commission (FCC), headquartered in Washington, D.C., was created in 1934 as an independent U.S. government agency empowered to regulate interstate and international communications by cable, satellite, wire, television, and radio. The FCC's authority covers the 50 U.S. states, the District of Columbia, and U.S. possessions. The FCC International Bureau (IB) is responsible for regulating spectrum usage by U.S. commercial spacecraft. The IB also shares expertise about the commercial satellite industry in the domestic spectrum management process and advocates U.S. satellite radio communication interest in international coordination and negotiations. In 2007, the FCC processed 232 new space and Earth station authorizations. The FCC's website also contains a number of databases and reports on spectrum usage by the U.S. commercial space industry.

The FCC does not have specific plans developing new services related to spectrum use by space transportation organizations.

ACCESSIBILITY OF SERVICES

Coordination of spectrum use by commercial spacecraft is handled by the FCC's International Bureau Filing System located on its website. Basic registration services are free of charge. Advanced services such as the registration of commercial communications satellites require bonds to ensure spectrum utilization.

INTERNATIONAL TELECOMMUNICATION UNION

Contact Information:
International Telecommunication Union (ITU)
Place des Nations
1211 Geneva 20
Switzerland
+41 22 730 5111
www.itu.int

SUMMARY OF SERVICES

- Manages the Master International Frequency Register for Equipment and Facilities
- Manages the procedures for spectrum assignment or allotment plans

BACKGROUND AND DEVELOPMENT PLANS

The International Telecommunication Union (ITU) is a United Nations agency focused on helping governments and the private sector provide information and communication technologies. The ITU is based in Geneva, Switzerland, and its membership includes 191 member countries and more than 700 private sector members and associates. The ITU Space Services Department is responsible for coordinating and recording procedures for space systems and earth stations. The ITU coordinates the deployment of space-based systems (satellites) that emit electromagnetic signals to minimize interference. The ITU coordinates use of spectrum of all nations or "administrations." The space services department manages the Master International Frequency Register that includes the responsibility of capturing, processing and publishing of data and examination of frequency assignment notices submitted by nation states. The space services department also assists nations to comply with ITU procedures and manages the procedures for space related assignment or allotment plans.

ACCESSIBILITY OF SERVICES

ITU space system databases are available for access at their website. ITU will provide assistance to countries to coordinate their spectrum use.

NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION

Contact Information:
NTIA
Herbert C. Hoover Building (HCHB)
U.S. Department of Commerce / NTIA
1401 Constitution Avenue, N.W.
Washington, D.C. 20230
www.ntia.doc.gov

SUMMARY OF SERVICES

- Manages the spectrum use of the U.S. Federal government
- Coordinates the registration of Federal government satellite networks
- Allows commercial access to the Institute for Telecommunications Sciences (ITS) a research and engineering laboratory

BACKGROUND AND DEVELOPMENT PLANS

The U.S. National Telecommunications and Information Administration (NTIA), created in 1978, advises the President on telecommunications and information policy issues. The NTIA represents the Executive Branch in domestic and international telecommunications and information policy activities. The NTIA also manages the U.S. Federal government's use of spectrum and conducts research and engineering to solve technical telecommunications issues for the Federal government and private sector. The NTIA manages the infrastructure and public telecommunications facilities grants. The Office of Spectrum Management develops and implements plans and policies that establish use of the spectrum nationally and internationally. The OSM coordinates the registration of Federal government satellite networks and allocates spectrum to satisfy the needs of Federal agencies.

The NTIA has offices in Washington D.C. and operates the Institute for Telecommunication Sciences (ITS), a research and engineering laboratory in Boulder, Colorado.

The NTIA may begin to collect fees in 2008 for the license of hybrid terrestrial-satellite mobile communications. Currently the licenses are granted free of charge. The NTIA also proposes legislation to competitively auction all domestic satellite services. Direct Broadcast Satellite and Satellite Digital Audio Radio Services were assigned by auction prior to a 2005 court decision. New legislation could restore the competitive bidding process.

ACCESSIBILITY OF SERVICES

The NTIA primarily provides services to other federal government entities. However, the ITS can be used for research that aids the private sector via the Federal Technology Transfer Act of 1986. The Act legally allows for commercial use of government facilities and resources to aid in development of advanced telecommunications technologies. Regarding access fees, a number of contracting vehicles are available for commercial access to the ITS.

Space Navigation Profiles

GLOBAL POSITIONING SYSTEM

Contact Information:
Air Force Space Command
Public Affairs Office
150 Vandenberg, Suite 1105
Peterson AFB, CO 80914
(719) 554-3731

U.S. Coast Guard Navigation Center
7323 Telegraph Road
Alexandria, VA 22315
(703) 313-5900
www.navcen.uscg.gov

SUMMARY OF SERVICES

- Navigation information – allows users on the ground and in air to locate any point on Earth
- Space travel navigation information
  - Rendezvous maneuvers: Space resupply systems can use GPS for navigation during rendezvous maneuvers with the International Space Station.
  - Constellation control: provides orbit maintenance of large numbers of space vehicles.
- Accurate, three-dimensional location and position information (latitude, longitude, and altitude)
- Precise and accurate time information, used by multiple systems for verification and other time sensitive applications
- Velocity
- Worldwide common grid

BACKGROUND AND HISTORY

The Global Positioning System (GPS) is a U.S.-built and -operated space-based radio-navigation system that provides users with worldwide positioning, navigation, and timing services. It consists of a constellation of between 24 and 32 MEO satellites that orbit the Earth at an altitude of approximately 11,000 miles and a network of ground stations used for monitoring and control.

GPS, initiated in 1973, was developed by the United States Department of

Defense. It was previously known as the Navstar Global Position System. The system was not made available for civilian use until 1983. The GPS consists of three parts: the satellites in orbit, the monitor and control earth stations, and the GPS receivers owned by users. The space and control segments are operated by the United States Air Force. The master control station is located at Falcon Air Force Base in Colorado Springs, Colorado. There are six monitor stations located at Falcon Air Force Base; Cape Canaveral, Florida; Hawaii; Ascension Island in the Atlantic Ocean; Diego Garcia in the Indian Ocean; and Kwajalein Island in the South Pacific Ocean. The monitor stations are responsible for routine checks and analyses of the orbiting satellites.

The United States is currently working on upgrades and advancements to GPS. The new developments will be introduced in three separate stages: Block IIIA, IIIB, and IIIC. Block IIIA is scheduled for launch beginning in late 2013. This GPS III system anticipates having new and multiple frequencies and 500 times greater transmitter power. The new developments will improve GPS usability, accessibility, and resistance to jamming to both military and civilian users. In addition, the European Galileo navigation system under development will improve the proposed GPS III system as they plan to be inter-operable.

Another developing service under consideration involves the Moon and the planet Mars. NASA is developing a plan to create a GPS-like network of satellites that orbit the Moon and Mars. This network could provide a navigation and communication network to aid in Lunar and Martian exploration and landing.

ACCESSIBILITY

GPS satellites provide service to civilian and military users. The civilian service is available to users worldwide. The military service is available to U.S. and allied armed forces as well as approved Government agencies. GPS is a service that provides users with instantaneous access. There are no fees from the U.S. government to use the GPS satellites for consumer products.

The current GPS system has Selective Availability (SA) which can, in effect, "shut down" the GPS system for civilian users, such as during times of war. However, the new GPS III satellites will not support SA, allowing for greater accuracy and reliability for GPS users.

OTHER INTERNATIONAL SPACE NAVIGATION PROGRAMS

A number of foreign countries are developing and operating global space based navigation systems. These countries include Russia, Europe, and China. Japan and India are developing smaller, regional systems not detailed in this report.

Development of Russia's GLONASS navigation system began in 1976 and a constellation was complete in 1995. However, the subsequent decline of the Russian economy reduced investment in GLONASS. Plans to revitalize the GLONASS system are under way in Russia and in early 2001 the Russian

government set a goal to add six satellites in 2009 and enhance the program to full global coverage by 2011. GLONASS expects to become a constellation of 24 satellites, as of September 2008, 19 satellites were estimated to be operational. The system transmits two types of signals: standard precision and obfuscated high precision. Russian president Vladimir Putin made GLONASS an open-access service. It is a civil service to Russian and foreign users free of charge.

Galileo is a global navigation satellite system that is under development in Europe. In 2002, the European Union decided to fund the project to develop the Galileo navigation system. On December 28, 2005, the first demonstrator spacecraft in the Galileo project was launched. A second spacecraft launched in April 2008. Galileo is similar to the United States' Global Positioning System (GPS) and is scheduled to be ready in 2013. The system plans to use a constellation of 30 satellites in MEO. Both the United States and Europe will benefit from the development of Galileo because there has been an agreement to make the two GPS and Galileo compatible and interoperable. Receivers will be able to connect with satellites in either constellation.

Compass is a global navigation satellite system under development by China. Compass is projected to use a 35-satellite constellation, with 5 in GEO and the remaining 30 in MEO. Compass-M1, the first experimental satellite for Compass, was launched in 2007. Compass plans to be an expansion of China's current Beidou system, developed by China Academy of Space Technology (CAST) under the China Aerospace Science and Technology Corporation. Compass plans to be a public service available globally to general users. There will also be a licensed service that provides greater accuracy restricted to use by authorized and military users. The system will initially cover China and its neighboring countries only but will eventually extend into a global navigation satellite network.

Meteorology Profiles

NOAA NWS SPACEFLIGHT METEOROLOGY GROUP

Contact Information:
National Weather Service
Spaceflight Meteorology Group
Johnson Space Center / WS8
Houston, TX 77058

SUMMARY OF SERVICES

- Weather analysis and forecasts
- Weather advice
- Monitor and evaluate weather at Space Shuttle landing sites
- Advice to the NASA flight director, flight control team, and mission management team during landings (meteorological support during manned spaceflight)

- Recommendations of appropriate landing scenario based on latest forecast
- Evaluates the Space Shuttle Weather Flight Rules
- Weather forecasts include: descriptions of clouds, visibilities, precipitation, winds, turbulence, temperature, altimeter setting, and density altitude
- Weather briefings include: synoptic explanations, the forecast rationale, and alternate weather scenarios
- Technique Development Unit (TDU) that customizes the Spaceflight Meteorology Group's (SMG's) Meteorological Data and Display System (MIDDS) for weather support

BACKGROUND AND DEVELOPMENT PLANS

The NOAA National Weather Service's (NWS) Spaceflight Meteorology Group (SMG) has been providing meteorology and weather forecasting support to the human spaceflight program at the Johnson Space Center since 1965. SMG was previously known as the Weather Bureau prior to 1970. In the late 1970s, the Automation of Field and Services (ATOS) division of the NWS was added to SMG's operation. Meteorological Data and Display System (MIDDS) has been providing satellite data and imagery to the SMG since 1988.

The Spaceflight Meteorology Group consists of eight NOAA/NWS meteorologists and one Consolidated Space Operations Contract (CSOC) meteorologist. MIDDS and WSR-88D Principal User Process (PUP) are the two systems of SMG that provide the analysis and forecasts.

The SMG is located at the Johnson Space Center in Houston, Texas. SMG also has facilities at the Kennedy Space Center (KSC) in Florida and the Edwards Air Force Base in California. SMG uses two facsimile machines to obtain maps from the National Meteorological Center, a Continental Meteorological Data System (COMEDS) terminal, Unifax satellite receivers, and a Closed Circuit Television (CCTV) system.

SMG is making future developments in manned spaceflight support for use once the next-generation Orion spacecraft enters operation. In addition, SMG has improved current human spaceflight missions by implementing new weather-focused space shuttle mission's simulations.

ACCESSIBILITY

SMG provides pre-mission and post-mission summaries for each Space Shuttle mission. The pre-missions summary is available three or four weeks before the expected launch. The summary includes the STS mission number, the predicted launch date, the orbiter name, the predicted landing date, crew information, payload descriptions, and the Transoceanic Abort Landing (TAL) locations. Any alterations to the weather flight rules are also included in the pre-mission summary. The post-mission summary, published three weeks after landing, include a description of the launch, the TAL, and the landing weather. The post-mission and pre-mission summaries are all accessible on NWS's SMG website free of charge.

Space Weather Profiles

NOAA SPACE WEATHER PREDICTION CENTER (SWPC)

Contact Information:
NOAA/ National Weather Service
National Centers for Environmental Prediction
Space Weather Prediction Center, W/NP9
325 Broadway, Boulder CO 80305
Phone: (303)497-7348
www.swpc.noaa.gov

SUMMARY OF SERVICES

- Alerts and forecasts of solar and geophysical events (daily, weekly, monthly)
- Reports and summaries (solar images, text reports, data lists, and data plots)
- Space weather models
- Solar and geomagnetic indices
- Instrument Measurements

BACKGROUND AND DEVELOPMENT PLANS

The SWPC, jointly operated by NOAA and the U.S. Air Force, is the nation's official source of space weather alerts and warnings. It continually monitors and forecasts Earth's space environment, provides solar-terrestrial information, conducts and leads research and development programs to understand the environment and to improve services, and advises policy makers and planners.

Organizational Structure :

National Oceanic and Atmospheric Administration
National Weather Service
National Centers for Environmental Prediction
Space Weather Prediction Center

The SWPC uses a number of assets including:

The Geostationary Operational Environmental Satellite (GOES) network. In addition to monitoring and predicting atmospheric weather, this multi-satellite observing system is also the foundation for many space weather forecasts, alerts, and warnings, using its onboard Space Environment Monitor (SEM) instruments (magnetometer, X-ray sensor, high energy proton and alpha detector, and energetic particles sensor).

The Polar Orbiting Operational Environmental Satellite (POES) network. POES monitors the particle radiation environment (just above Earth's atmosphere), which potentially can impact radio communication and navigation, satellite operations, and the well being of personnel traveling on high-altitude aircraft.

The Advanced Composition Explorer (ACE) Real Time Solar Wind Application. NOAA also has access to the ACE spacecraft, a NASA Explorer mission, which studies the solar winds from a point approximately 1.5 million kilometers above the Earth. The spacecraft also studies interplanetary magnetic fields and higher energy particles accelerated by the Sun, as well as particles accelerated in the heliosphere and the galactic regions beyond. NOAA partnered with the ACE project and setup the ACE Real Time Solar Wind (RTSW) monitoring capability, which can provide up to one hour's warning of CMEs that can cause geomagnetic storms on Earth.

Future development plans include:

- GOES-O launch: late 2008 or early 2009
- GOES-P launch: as early as December 2009
- GOES-R launch: 2015, with additional instrumentation, including Space Environment In-Situ Suite (SEISS), Extreme Ultraviolet Sensor/X-Ray Sensor Irradiance Sensors (EXIS), and Solar Ultraviolet Imager (SUVI)
- The National Polar-orbiting Operational Environmental Satellite System (NPOESS) launch: 2013, allowing forecasters to predict Earth's atmospheric and near-space environment weather patterns with greater speed and accuracy
- The ACE spacecraft reached the end of its design life in 2003. There are no current plans to replace it, however, a fuel-use strategy has been implemented that will allow continued operations through 2024.

ACCESSIBILITY

All services are open to the public via their website at no charge. Their "Space Weather Now" site, accessible at www.swpc.noaa.gov/SWN, provides a near real-time snapshot of space weather conditions such as solar wind activity, latest imagery, solar activity forecasts, and geomagnetic field activity.

The SWPC offers email alerts and forecasts via free subscription service, accessible at www.swpc.noaa.gov/alerts/index.html.

The ACE RTSW monitoring site is available at sec.noaa.gov/ace/index.html

EUROPEAN SPACE AGENCY - SPACE ENVIRONMENTS AND EFFECTS SECTION

Contact Information:
Space Environments and Effects Section
ESTEC/TEC-EES
Keplerlaan 1 - 2200 AG Noordwijk
The Netherlands
Fax: +31-71-56 54999
Swenet@etamax.de

SUMMARY OF SERVICES

- Space-weather Operational Airline Risks Service (SOARS)
  - Predictions of the radiation risk to humans onboard aircraft; onboard avionics for given routes
  - Forecasts of the impact of space weather effects on HF communications
- "Auroras Now!" site
  - General information about auroras and space weather
  - Current magnetic activity level and near real-time images
- Multiple indices and forecasting tools for
  - Geomagnetic and Geomagnetically-Induced Current (GIC) Activities
  - Potential Impact on Radio Communications
  - Potential Impact on Satellite Navigation Systems
  - Satellite Anomalies and Operational Support
- Email Alerts

BACKGROUND AND DEVELOPMENT PLANS

The Space Environments and Effects Section is the ESA's focal point for analyses of the physical environment in space and its effects on space systems and astronauts. The Section is also the driving force behind the ESA Space Weather applications initiative, which has led to the online tool called The Space Weather European Network (SWENET), a series of applications, services, and data products that enable registered users access to data and services on space weather and environment and its effects. SWENET collects data through several external sources including the NOAA SWPC and makes it available through a common database.

Development plans include:

- Partner websites/databases linked to the SWENET portal
- Website is continually upgraded with user friendly services such as email alerts and interface enhancements. Animated images are now being generated.

ACCESSIBILITY

SWENET data are accessible via their website at www.esa-spaceweather.net /swenet/index.html, (free registration is required). Alerts can also be sent via email.

The Solar Heliospheric Observatory (SOHO) website is free and open at sohowww.nascom.nasa.gov, and provides near real-time solar images and space-weather conditions. The SOHO spacecraft was launched in 1996 as part of a joint project between ESA and NASA. It is in a similar orbit to the ACE spacecraft, and studies the Sun and the solar wind.

THE INTERNATIONAL SPACE ENVIRONMENT SERVICE (ISES)

Contact Information:
Geological Survey of Canada
Geomagnetic Laboratory
7 Observatory Crescent
Ottawa, Ontario
Canada, K1A 0Y3
(613) 837-4241 FAX: (613) 824-9803
http://www.ises-spaceweather.org

SUMMARY OF SERVICES

- Space weather forecasts
- Warnings of disturbances to the solar-terrestrial environment
- Facilitation of scientific study and experimentation
- Monthly bulletins on satellite activity, including launches and predicted orbit decay
- Organized workshops focused on improving forecasting capabilities

BACKGROUND AND DEVELOPMENT PLANS

ISES is a permanent service of the European-based Federations of Astronomical and Geophysical Data Analysis Services (FAGS), and is administered primarily the International Union of Radio Science (URSI) in association with the International Astronomical Union (IAU) and the International Union of Geodesy and Geophysics (IUGG). ISES coordinates the exchange of data amongst 12 Regional Warning Centers (RWCs) around the world. The RWC supporting the United States is the NOAA's aforementioned Space Weather Prediction Center. The RWCs' primary function is to provide their solar-terrestrial forecasting services to user communities within their own region. Such users include high frequency (HF) radio communicators, power line and pipeline authorities, and satellite operators. The RWCs also benefit the entire ISES community by collecting and share data from their region with the other centers through the ISES network.

ACCESSIBILITY

ISES has developed a comprehensive space weather website (www.spaceweather.org). It serves as a gateway to a variety of information about space weather topics, provides information on current space weather conditions in the Solar system, and details historic and forecasted space weather conditions. The site also provides direct links to the eleven RWCs and their products and services such as alerts, forecasts, and predictive models.

Generally, the accessibility of information from these RWCs is open and available via several electronically delivered methods. Their websites are regularly updated, and alerts can be given via email, SMS, or via anonymous FTP servers. At times, access to these services may require registration with the site.

Crew Rescue Profiles

RUSSIAN FEDERAL SPACE AGENCY (ROSCOSMOS)

Contact Information:
St. Schepkina 42,
Moscow, Russia,
GSP-6, 107996
+7-495-631-9768
www.roscosmos.ru

SUMMARY OF SERVICES: SOYUZ-TMA SPACECRAFT

- Crew and supply transport to the International Space Station (ISS)
- Space tourism vehicle
- Fixed emergency lifeboat vehicle on ISS

BACKGROUND AND DEVELOPMENT PLANS

The Soyuz-TMA (Transport-Modified-Anthropometric) design is the most recent revision of the Russian Soyuz vehicle, and is the world's longest-serving and one of the most reliable manned spacecraft. It can carry up to three crew members and supplies to the ISS, and remains attached to the ISS for up to six months as a "lifeboat" and return vehicle in the unlikely event of in-orbit emergency that requires evacuation from the station. The TMA is also the vehicle used by the space tourism company Space Adventures Ltd. for private flights to the ISS.

There are proposals to replace the Soyuz with alternate vehicles including the Advanced Crew and Transportation System.

ACCESSIBILITY OF SERVICES

This program-specific contingency plan should not be considered as accessible to the commercial space industry. It is intended to provide some basic background in case a partnership with Roscosmos is being considered for rescue services.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Contact Information:
Public Communications Office
NASA Headquarters
Suite 5K39
Washington, DC 20546
(202) 358-0001 Fax: (202) 358-3469
www.nasa.gov

SUMMARY OF SERVICES: SPACE SHUTTLE

- Crew and supply transport to the International Space Station (ISS)
- Contingency Shuttle Crew Support (CSCS)

BACKGROUND AND DEVELOPMENT PLANS

NASA is the U.S. agency that is responsible for the nation's public space program and aerospace research. NASA's Space Shuttle – officially called the Space Transportation System (STS) – has flown more than 100 missions since its initial launch in 1981.

The Contingency Shuttle Crew Support (CSCS) plan would be implemented to sustain a stranded shuttle crew on-board the ISS while a second shuttle rescue mission is prepared and launched. The ISS serves as an "on-orbit safe haven", capable of supporting up to six additional crew members (above normal crew contingent of three persons) for a limited time. NASA aims for any rescue mission to be able to launch within 35 days of request, and return as many as seven additional crew members from the ISS.

The shuttle is scheduled to be retired in 2010, with no replacement expected until 2015 when the new Orion spacecraft and the Ares I launch vehicle become operational. Lockheed Martin is contracted to design and build Orion, which would continue the STS crew rescue role.

ACCESSIBILITY OF SERVICES

This program-specific contingency plan should not be considered as accessible to the commercial space industry. It is intended to provide some basic background in case a partnership with NASA is being considered for rescue services.

NASA has not yet elected to pursue a commercial crew transportation services under Commercial Orbital Transportation System.

Technician Training Profiles

SPACETEC

Contact Information:
SpaceTEC
Mail Code SpaceTEC
Kennedy Space Center, FL 32899
(321) 730-1020
www.spacetec.org

SUMMARY OF SERVICES

- Develops and coordinates administration of the exams for Certified Aerospace Technician
- Subjects covered within the Core certification include: Introduction to Aerospace, Applied Mechanics, Basic Electricity, Test & Measurements, Materials and Processes and Aerospace Safety

BACKGROUND AND DEVELOPMENT PLANS

SpaceTEC was established in 2002 after the National Science Foundation awarded a three-year grant to the Community Colleges for Innovative Technology Transfer. SpaceTEC's mission is to create and implement an industry-driven, government-endorsed, technical education process for aerospace technicians that can be shared with other educational venues. SpaceTEC draws upon an advisory committee with representatives from the Florida Aviation & Aerospace Alliance, a large number of NASA centers and commercial companies. SpaceTEC has developed written, oral, and practical tests that lead to the Certified Aerospace Technician certification. The tests are administered at partner facilities by authorized SpaceTEC Examiners.

SpaceTEC's home offices reside in Florida and its partner organizations are located around the country.

SpaceTEC continues to identify and partner with organizations who want to offer aerospace technician certification. New services that SpaceTEC is planning to rollout in late 2008 include concentrations in vehicle processing, manufacturing, and composites.

ACCESSIBILITY OF SERVICES

SpaceTEC certification is open to all qualified applicants. Specific qualifications and partnering institution are identified on SpaceTEC's website. Practice exams and instructional materials are available on the website.