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Special Issue: China's Space Development

Achievements and Prospects of China's Space Development

Mr. Xu Dazhe, Chairman of China Aerospace Science and Technology Corporation (CASC) delivered a speech at the 64th International Astronautical Congress (IAC) on September 23, 2013, sharing experiences gained in the development of China's space industry with international colleagues.

OUTSTANDING ACHIEVEMENTS MADE BY CHINA'S SPACE INDUSTRY

China's space programs have had 57 years of development since the 1950s. The successful launch of China's first artificial satellite Dongfanghong 1 (DFH-1) in 1970 marked the start of China entering into space and exploring the universe. Due to substantial governmental support and promotion, China's space industry developed quite fast and has made world-known achievements.

As the leader in China's space sector, CASC is assigned to develop, manufacture and test launch vehicles, manned spaceships, various satellites and other spacecraft for major national space programs such as China's Manned Space Program, China's Lunar Exploration Program, BeiDou Navigation Satellite System, and China's High-Resolution Earth Observation

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System. The new generation of launch vehicles, deep space exploration detectors, space labs and China's space station are also under development by CASC.

As for China's Manned Space Program, 10 Shenzhou spaceships and the Tiangong 1 target spacecraft have been launched into space with technical breakthroughs being made in manned spaceflight, ex-vehicular activity, space rendezvous and docking. The flight test with rendezvous and docking between the Shenzhou spaceship and Tiangong 1 was also achieved.

In line with China's Lunar Exploration Program, the Chang'e 1 lunar satellite completed its orbiting mission. Chang'e 2, the pioneering satellite of the second phase of the China's Lunar Exploration Program, captured 3-dimentional images of the full moon with a resolution of 7 meters and high-resolution images of the Sinus Iridium (Bay of Rainbows). After completing all the assigned missions, the satellite traveled around the second Lagrange Point (L2) and flew by the asteroid Toutatis, about seven million kilometers away from the Earth and is flying further into deep space. The Chang'e 2 satellite is operating at a distance farther than 54 million kilometers away from the Earth and keeps renewing the record of China's deep space exploration.

The regional BeiDou Navigation Satellite System was accomplished and put into operation. Composed of 14 satellites, the system provides passive positioning, navigation and timing services with a positioning resolution of better than 10 meters to China and surrounding countries and regions. The system is also supplemented by short-message communication and two-way timing.

High-Resolution Satellite 1 (GF-1), the first satellite of the China's High-Resolution Satellite System, was launched into space, and will be followed by the launch of GF-2. The system will be used to strengthen the nation's space-based, air-based and near-space data acquisition capacity and to meet the urgent requirement for high-resolution observation data. The comprehensive abilities of ground reception, processing and distribution of space data will be improved since high-resolution observation data is needed badly for the development of the national economy.

So far 232 satellites have been launched by China including 26 piggybacked satellites and 105 operational satellites. Applied satellites have matured from experimental to operational phase, thus building up China's initial space infrastructure and are widely used to satisfy social and economic development.

CASC has indigenously developed three generations of the DFH series of communications satellite platforms and developed more than 20 fixed-service communications satellites, which cover 58 percent of the global land area, 80 percent of the global population with television relay, communications and broadcasting services. Spot beams of the satellites have covered Asia, Oceania, Europe and some regions in Africa. CASC is both the manufacturer and operator of these satellites.

China has several remote sensing satellite series such as Fenyun (FY) meteorological satellites, Haiyang (HY) oceanographic satellites, Ziyuan (ZY) land resources surveying and mapping satellites and an environmental and disaster monitoring and forecasting satellite constellation, which are operating continuously and steadily. Currently, China's resources observation satellite system is capable of capturing imagery with 2m panchromatic resolution, 8m multi-spectral resolution and surveying and mapping with a scale of 1:50000. The constellation of environmental and disaster monitoring and forecasting satellites is operating in a network with capacity to take visible, infrared and microwave imagery. Oceanographic satellites monitor and capture information on ocean color and the dynamic environment. Two GEO meteorological satellites are operating as backup in orbit and SSO meteorological satellites are operating with morning and afternoon satellites as part of the network.

FY-3C, the third satellite in the FY-3 series, was launched on September 23 to improve the capacity

of monitoring global meteorological phenomena, all-weather, through multi-spectral, 3-dimentional and quantitative remote sensing. The mission signified the development and application of China's meteorological satellites had entered into a new phase.

Our LM launch vehicles have grown into 4 series and 10 types of mature products, capable of launching spacecraft into high, middle and low Earth orbits. LM launch vehicles are capable of sending 8.6t payload into LEO orbit, 2.8t payload into SSO orbit and 5.5t payload into GTO orbit.

LM launch vehicles have performed 181 missions up until the FY-3C mission with a success rate of 95.6 percent. China's new generation of launch vehicles is under development, and will perform their first flight around 2015. The new generation launch vehicles will be capable of launching payload up to 25 tons into LEO orbit, 13 tons into SSO orbit and 14 tons into GTO orbit.

BROAD PROSPECTS OF CHINA'S SPACE DEVELOPMENT

Space technology has never become so close to our daily life like now in China, changing our life style in many ways from weather forecasting to vehicular navigation, from communications and broadcasting to environmental monitoring, and from land resources management to the building of smart city. It is our continuous dream to develop the space cause and to become a space power.

China's space industry enjoys very broad prospects and is moving forward with firm steps following the planned blueprint.

1.To implement the national major space programs step by step. In line with China's Manned Space Program, the Tiangong 2 space lab will be launched to evaluate the performance of the national space station in the area of regenerative life support and propellant refueling for the space station. Cargo spaceships and manned spaceships will be launched to dock with the space station. Finally a long-term man-tended space station will be constructed, where considerable research and applications in space science will be conducted.

According to the plan of China's Lunar Exploration Program, lunar landing and roving will be achieved during the second phase of the Program. Chang'e 3 lunar exploration satellite will be launched in December 2013 to conduct the lunar landing mission, which will fill the gap of no moon landing in almost 20 years.

Based on the regional BeiDou Navigation Satellite System, a passive global navigation satellite system will be completed around 2020 utilizing 30 high-resolution satellites to provide high-resolution and high-reliability positioning, navigation and timing services.

Under the major projects, China's High-Resolution Earth Observation System, an optical imagery satellite with 1m panchromatic resolution and 4m multispectral resolution, a C-band multipolarization SAR satellite, a GEO optical imagery satellite, a hyperspectral Earth observation satellite, and a high-resolution territory land survey and mapping satellite will be developed and launched to provide satellite remote sensing data with highspatial, high-temporal and high-spectral resolution for social and economic development.

2.To perfect the current applied satellite systems. The FY-4 meteorological satellite for optical exploration, the oceanographic radar observation satellite, and the land resources observation satellite will be developed and launched to upgrade the communications satellite series, meteorological satellite series, oceanographic satellite series and resources satellites, to satisfy the economic and social requirements for space infrastructure.

3.To speed up researches on deep space exploration and space sciences. Planning and demonstrations will be further conducted on heavy lift launch vehicles and deep space exploration. Project concepts will be proposed in due time for the Mars orbiting mission, Asteroid accompanying attached detector, deep space solar

observatory, solar polar detection and sample returning from Mars, etc. Technical support for deep space exploration and deep space science will be promoted rapidly.

4.To continually conduct researches on new technologies for applied satellites. Development will be carried out for systems including DFH-5 large communications satellite platform, advanced satellite mobile communications system, laser communications, millimeter wave and sub-millimeter wave detectors, atmospheric sounding laser radar, high-resolution infrared imaging system and payload technology. Research on autonomous pulsars navigation, quantum information, Terahertz and new space propulsion technology and space applications will be conducted. Technical reserves need to be enriched continuously to meet the demand of rapid social and economic development.

5.To speed up transfer and application of space technology. Satellite application system will become more complete by encouraging applications with remote sensing satellite data, satellite mobile communications and in the satellite navigation industry, etc. High and new space technologies will be transferred more and more to strategic emerging industries including those in energy-efficiency and environmentally friendly next-generation information technology, biology, high-end equipment manufacturing, new energy and new materials.

The endless space is the common territory of all human beings. The development of space by China is always based on the purpose of peaceful use of outer space and for the goodness of all human beings. With the global trend of rapid scientific and technological development, China's space industry meets the important challenge. China's President Xi Jinping called "to develop space industry and build up a powerful space country" after the successful rendezvous and docking mission between the Shenzhou 10 spaceship and the Tiangong 1 target spacecraft.

With "Create human space civilization and build national science and technology monument" as its mission, CASC insists on promoting the development of China's space industry, expanding fields in space technology applications to provide support for social and economic development of the nation.

Simultaneously, CASC welcomes cooperation with all governments, international space organizations like IAF, enterprises and other stakeholders, who share the common goal of promoting the development of space technology bringing benefits to human kind.

The 64th IAC Held in Beijing

With the theme of "Promoting Space Development for the Benefit of Mankind", the 64th International Astronautical Congress (IAC) was held in Beijing from September 23 to 27, 2013, thus providing an opportunity for global space professionals to share their experiences and studies on various researches with international colleagues through 180 technical sessions, 8 plenary events, 3 highlight lectures and other formal and informal meetings. More than 3000 delegates from the world space sector attended the Congress. World-wide scientists, researchers and engineers introduced their latest studies and programs during the technical sessions which were welcomed warmly by counterparts from the world. New ideas were inspired occasionally and cooperation possibilities appeared and created. Experienced scientists and researchers made pertinent

comments to benefit future studies and provided students and young professionals with networking opportunities.

Heads from more than twenty space agencies attended the Congress to highlight their latest developments and share their ideas on future space projects and international cooperation. They interacted with each other and dialogued with audience from world space stakeholders and passionate young professionals. Space companies showed their latest capabilities through the exhibition, technical sessions and symposiums to impress potential partners.

Hosted by the Chinese Society of Astronautics (CSA), the 64th IAC was the second time for China to host IAC since the 47th IAC, which was held in Beijing in 1996. With a local organizing committee (LOC) comprised by high-level representatives from all key space sectors of China, ranging from government to industry and academia, the 64th IAC was substantially supported with abundant resources.

As one of the local organizers, China Aerospace Science and Technology Corporation (CASC) participated in the 64th IAC with unprecedented scale and talked with international counterparts through bilateral and multilateral visits and meetings. Besides attending and presenting on plenary meetings, technical sessions and exhibition in the 64th IAC, CASC invited delegates worldwide to visit its facilities where launch vehicles, satellites and spaceships are developed. CASC shared its programs on space science, space transportation system, remote sensing satellites, communications satellites and space technology applications to seek future opportunities for international cooperation.

During the 64th IAC, CNSA Administrator Ma Xingrui disclosed that China would open its space station and welcome international cooperation. IAA President Madhavan Nair commented on the issue in the interview, as saying that currently the international space station only has several participants in the global community, and the developing countries will especially benefit if China opens its space station for other countries.

Shenzhou 10 Misson Successfully Accomplished

After 15 days' flight in space, the return module of Shenzhou 10 landed in the preset area in the middle of the Inner Mongolia Autonomous Region at 08:07 Beijing Time on June 26, 2013. Crew members Nie Haisheng, Zhang Xiaoguang and Wang Yaping were in good health and came out of the module. Tiangong 1 and Shenzhou 10 manned spaceflight mission achieved a full success.

The Shenzhou 10 spaceship was launched from the Jiuquan Satellite Launch Center at 17:38 Beijing Time on June 11. During the Shenzhou 10 mission, technological tests of automatic and manual rendezvous and dockings and flying around were conducted and a lecture oriented to students nationwide was given. The success of the mission marked the ending of the first phase of the second step of China's Manned Space Program and the beginning of a new stage of space station construction.

As the best platform for space exploration, the space station is the utmost goal in the three-step strategy for China's Manned Space Program. According to the strategy, China is to launch Tiangong 2 space lab around 2015 and to build an autonomous space station around 2020.

At the press conference held on June 26, 2013 by the State Council Information Office, Vice President of

China Aerospace Science and Technology Corporation (CASC) Yuan Jie said, the complete success of Tiangong 1 and Shenzhou 10 manned spaceflight mission marked that China has entered into the space station era. To further meet the needs of development of space science, space technology and space applications, China will strengthen the construction of its space transportation system, optimize gradually the rocket type spectrum to raise the ability to access space and improve the reliability and adaptability of existing launch vehicles.

Chang'e 3 Achieved Soft Landing on the Moon

The Chang'e 3 lunar exploration satellite was launched into space on a LM-3B launch vehicle from the Xichang Satellite Launch Center on December 2, 2013. 19 minutes after the lift-off, Chang'e 3 separated with the carrier rocket and entered accurately into an Earth-lunar transfer orbit with a perigee of 210km and an apogee of 370,000km.

At 17:53 on December 6, through one brake by a 7500N variable-thrust engine, which was newly developed by China, Chang'e 3 was captured by the moon and entered a circumlunar orbit with an average height of 100km above the lunar surface. The orbit of the satellite was reduced to a 15km×100km elliptical orbit on December 10 and the probe made a soft-landing on the moon on December 14.

Chang'e 3 was composed of a lander and a rover (Yutu lunar rover). The lander and the rover separated on December 15 and took pictures of each other on December 16. The image of China's five-starred red flag on the moon was transmitted back to the Earth. The landing of the lander and roving of the rover on the moon indicated that five systems of the project had completed their preset tasks, making the mission a full success and the realization of the first soft landing, roving and exploration on an extraterrestrial body of China's spacecraft.

Chang'e 3 project, the second strategic goal of China's Lunar Exploration Program with three steps of "orbiting, landing and returning", was approved in February, 2008. During the implementation of the project, a number of major key technological breakthroughs have been made in areas including soft landing, lander-rover separation, remote operation between the Earth and the moon, survival on the moon and TT&C and communications, and a batch of scientific and technical solution on which intellectual property rights have been independently achieved. Chang'e 3 mission realized "7 innovations" in China's space field: first soft landing on an extraterrestrial body of a China spacecraft; first roving survey on an extraterrestrial body using a China spacecraft; first remote operation of lunar surface probe; first development of China's larger deep space station and initial establishment of a deep space TT&C communications network covering interplanetary space; first scientific observation using multiple techniques on the lunar surface; first test for probe survival on the lunar surface with its extreme temperature environment; first development and construction of a series of advanced special test equipment and forming a series of advanced innovating test methods.

The success of the Chang'e 3 mission marks that the China's Lunar Exploration Program (CLEP) has shifted into a new phase: unmanned automatic sampling and returning. The Chang'e 5 project of Phase III of CLEP was approved in 2011, and the development continues well. It is expected to complete the development of Chang'e 5 probe and launch around 2017.

GF-1 Satellite - The First Satellite of CHEOS

As the first satellite of the China's High-Resolution Earth Observation System (CHEOS), GF-1 (High-Resolution Satellite 1) was developed to realize breakthroughs focusing on high spatial resolution, optical remote sensing technique, integrated multi-spectral and high spatiotemporal resolution, fusion and mosaic technologies with images captured by multiple payloads, high-precision and high-stability attitude control technology, operating for 5 - 8 years in LEO orbit with high reliability, high-resolution data processing and application technologies. The satellite will be used to improve the overall performance of national satellite projects and increase the utilization percentage of high-resolution satellite data provided by the national satellites.

After 30 months of development, the GF-1 satellite was launched into space by a LM-2D launch vehicle from the Jiuquan Satellite Launch Center (JSLC) on April 26, 2013.

Recently, GF-1 has successfully accomplished more than one year on-orbit commissioning, and has officially been put into practical use. The satellite can provide important data support for areas including territorial resources survey, comprehensive utilization in agriculture, environmental protection and disaster prevention and mitigation.

High-Resolution Earth Observation Major Special Project Center organized the review on the GF-1 satellite on-orbit commissioning. The working process, testing items and conclusion during the GF-1 on-orbit commissioning were introduced in detail, and the results were also introduced in four parts: satellite system testing, satellite-Earth integration testing, ground systems testing and application systems testing.

China Spacesat Co. Ltd, subordinated to CAST, was in charge of the development of GF-1 with related index that has reached the level of the same satellite data products abroad. Through the evaluation of application of data products in related remote sensing application demonstration systems including land resources, environmental protection and agriculture, the related industries could make use of GF-1 data to conduct related businesses.

GF-1 on-orbit commissioning report passed the review smoothly, marking the end of the on-orbit commissioning which were jointly conducted by China Centre for Resources Satellite Data and Application, CAST, China Xi'an Satellite Control Center, and related user departments of land resources, agriculture and environmental protection. GF-1 will play a more and more important role in the following application phase.

(Provided by Department of International Cooperation, China Aerospace Science and Technology Corporation)