Document 4-4

Japan Aerospace Exploration Agency
Flowcharts for Achieving
Next Mid to Long-term Objectives
(Draft)

* The “Approach (draft)” column at the bottom indicates the plans which will be incorporated in the next Mid to Long-term Plan.

III. 3. 1. Satellite positioning systems

Present state analysis (politics/social trends)

- Satellite positioning is essential for security, public lives and social and economic activities
- Expectations for the space industry are increasing as a growing industry in Japan
- Worldwide progress of satellite positioning technologies makes international competition fiercer

Issues to solve = Outcomes to produce

- Assurance of Japan's security and industrial promotion
- Progress of the positioning system in Japan

Output

R&D of basic satellite positioning fundamental technologies with durability in mind for:

- Advanced positioning system in Japan
- High precision positioning data distribution service

Approach (draft)

- R&D of satellite positioning technologies including MADOCA and precise orbit control technologies
- Support of commercializing accurate positioning data services by private business operators through the joint initiatives between the government and private sectors

III. 3. 2. Satellite remote-sensing

Present state analysis (politics/social trends)

- Satellite data including security is essential for the government and industry
- Expectations for the space industry are increasing as a growing industry in Japan
- Use of remote sensing and other satellite data is expected to used in various fields including the field of security

Issues to solve = Outcomes to produce

- Realization of a safe and secure society through contribution to disaster management and response
- Solution to global issues through contribution to climate change measures
- Industrial promotion and use of public satellite data in various areas

Output

R&D, operation and utilization of advanced remote sensing satellites for:

- A wide use of data as critical information directly affecting disaster mitigation such as the issue of evacuation
- Common use of data as indexes of decision making or evaluation in climate change measures
- Promotion of satellite data through increased areas of application

Approach (draft)

- Prompt distribution of accurate satellite data to disaster prevention agencies and local governments while improving observation frequency, accuracy and swiftness
- Supply of climate change related satellite data to users in Japan and abroad, upgrading of observing sensor performance, and R&D of observation data calibration and validation, etc.
- R&D and demonstration of satellite data processing and analysis in proactive government-private sector collaboration
- R&D of advanced satellite technologies including the integration and use of satellite functions

III. 3. 3. Satellite communications

Present state analysis (politics/social trends)

- Satellite communication is essential for security, public lives and social and economic activities
- Expectations for the space industry are increasing as a growing industry in Japan
- International satellite industry and market are expanding (communications and broadcasting related service industry accounts for more than 60 percent)

Issues to solve = Outcomes to produce

- Upgrading of satellite communication technologies in response to recent needs for high-capacity communications
- Increase in market share of private business operators in the world's commercial communications satellite market in the 2020s
- Assurance of national security and industrial promotion by increasing data transmission capacity

Output

- Acquisition of next-generation geostationary communications satellite bus technologies having international competitiveness through R&D and demonstration of next-generation communications satellite buses
- Large data transponders for future upgraded/high-resolution remote sensing satellites through R&D and demonstration of optical inter-orbit communications technology

Approach (draft)

- R&D and demonstration of next-generation communications satellite bus technologies having international competitiveness such as electric propulsion, high waste heat management and geostationary GPS receiver technologies
- R&D of optical inter-orbit communication technologies with better confidentiality in data transmission, and on-orbit demonstration of optical data transponders and advanced optical satellites

III. 3. 4. Space transportation system

Present state analysis (politics/social trends)

- Space development and utilization including security are essential for the government and industry
- International competitiveness of launch service is increasing due to the rise of emerging nations and private business operators
- Global space utilization activities increase demand for launch service
- Expectations for the space industry are increasing as a growing industry in Japan

Issues to solve = Outcomes to produce

- Completely independent and seamless space transportation capability
- Improvement of self-controlling launch capability and international competitiveness
- Independence of Japan in space businesses, and improvement of international competitiveness and economy

Output

- Maintenance of world's highest launch success rate and on-time launch rate with H-11A/H-IIB rockets
- Prompt completion of H3 rocket development and move to private satellite launch services
- Continued success of launch of Epsilon Launch Vehicle, and completion of transfer operation to private satellite launch services
- Continued improvement of space transportation technologies in Japan

Approach (draft)

- Continued improvement of reliability of H-IIA/H-IIB rockets, and maintenance of basic technologies including anti-aging measures
- Steady development of an integrated system for H3 rocket, completion of transfer operation to private launch services, and increase in maturity at initial operation stage
- Development and flight demonstration of synergy effects in Epsilon Launch Vehicle and H3 rocket, and completion of transferring operation to private launch services
- Research on reuse of the 1st stage of rocket

III. 3. 5. Space situational awareness

Present state analysis (politics/social trends)

- Continuous and safe utilization of outer space is critical for Japan to maintain public lives and social and economic activities as well as national security
- Congestion in outer space due to increase in nations active in space and increased threats and risks posed by space debris
- The Basic Plan for Space Policy indicates “the establishment of the Space Situational Awareness (SSA) by around early 2020s”

Issues to solve = Outcomes to produce

- Continuous and safe utilization of outer space in national security and civilian use

Output

- Contribution to establishing an interministerial SSA operation system through R&D to improve SSA capability by establishing and operating JAXA-owned SSA related facilities, and sharing technology and knowledge with related organizations

Approach (draft)

- Establishment and operation of JAXA-owned SSA related facilities
- R&D for improving space debris observation, and access/collision preventing technologies
- Technical support to the government including personnel exchange with related organizations
- Continuous operation of preventing collision with space debris

III. 3. 6. Maritime Domain Awareness and early warning functions

Present state analysis (politics/social trends)

- Outer space and space systems are essential for the basis of security
- Various artificial and natural threats and risks in the ocean have become obvious
- Maritime domain awareness (MDA) for responding to these threats and risks is the pressing and increasingly important issue in national ocean and security policies

Issues to solve = Outcomes to produce

- Assurance of national security using outer space and space systems

Output

- R&D and operation of advanced earth observation satellites and Automatic Identification System (AIS), related data processing and analysis technologies, and use of satellite data for contributing to more detailed understanding of maritime situations
- Promotion of government investigation in collaboration with the Ministry of Defense, Japan Coast Guard and other security-related organizations, and supply of information concerning advanced earth observation satellites, etc.

Approach (draft)

- R&D of advanced earth observation satellites and technologies to improve the vessel detection rate of Automatic Identification System (AIS) for obtaining vessel information from satellites, and demonstration of technologies that show accurate marine navigation state of vessels by the coordinated observation with advanced radar satellites
- Installation of infrared sensors on advanced optical satellites
- R&D of element technologies required in future according to the government investigation into the assurance of Japan's early warning capacity
- R&D to meet needs for future space utilization in national security

III. 3. 7. Enhancement of the overall mission assurance of space systems

Present state analysis (politics/social trends)

- Dependency of security, public lives and social and economic activities on space systems is increasing while threats and risks to space systems are also growing. Assurance of safe utilization of space is the pressing issue
- Increasing needs for strengthening the Mission Assurance including satellites and ground facilities to prevent unexpected incidents in space from adversely affecting national security

Issues to solve = Outcomes to produce

- Strengthening of Mission Assurance of all space systems in Japan

Output

- Progress of the government investigation through technical support such as supply of knowledge about development and operation of space systems
- Strengthening of the Mission Assurance for all space systems by evaluating their vulnerability

Approach (draft)

- Technical support of security related organizations including the Cabinet Office and Ministry of Defense concerning Mission Assurance of overall space system, including the form of launching sites and quick reaction type small satellites
- Based on “Fundamental Approach for Strengthening of Mission Assurance (joint meeting of relevant government offices for strengthening the survivability, April 20, 2017), evaluation of space system vulnerabilities and promotion of required work according to the evaluation results

III. 3. 8. Space sciences and exploration

Present state analysis (politics/social trends)

- Continuing needs for producing intellectual property common to all humankind by consolidating a great amount of expertise in space science and exploration
- Instability of Japan's presence and technical advantages in space science and exploration due to the rise of emerging nations like China and India and private business operators

Issues to solve = Outcomes to produce

- Exploitation of new space development and utilization
- Creation of the world's best scientific outcomes
- Maintenance and improvement of Japan's international presence

Output

- Creation of scientific outcomes by accomplishing space science and exploration missions and promoting research
- Acquisition of innovative and exploratory technologies allowing the expansion of our activities in outer space
- Contribution to human resources development from a long-term standpoint
- Social return including industrial promotion in collaboration with private business operators

Approach (draft)

- Development, launch and operation of satellites, probe vehicles and small flying objects (observation rockets, large balloons)
- Publication of observation data in a manner that allows a wide use in the world
- Establishment of a system ensuring the development, mobility and diversity of human resources
- Cooperation in postgraduate education for fostering human resources who determine the future of Japan

III. 3. 9. International Space Station

Present state analysis (politics/social trends)

- Instability of Japan's presence and technical advantages in manned space activities due to rise of emerging nations like China and India
- Expansion of manned space activities by various players including private business operators
- Importance of multilateral partnerships including Japan-US cooperation

Issues to solve = Outcomes to produce

- Innovation, industrial promotion and increased space utilization using the ISS
- Maintenance and improvement of Japan's international presence
- Reinforced international partnerships including Japan-US cooperation

Output

- Promoting a wide use of "KIBO" as R&D infrastructure to support STI in industries, universities and government, and independent private service businesses for "KIBO" utilization, etc. by 2020
- Improved capacity to deliver supplies to the ISS by upgrading HTV, and reduced operation costs

Approach (draft)

- Regular, frequent and fixed (platform type) "KIBO" utilization services (support for new drug design and aging study, discharge of ultra-small satellites, and use of extravehicular ports)
- Selection of private business operators for end-user services and technical transfer
- Development and operation of a new space station replenishment machine
- Demonstration of manned space residency technology, automatic/autonomy technologies, space medicine/health control technologies, etc. using the ISS

III. 3. 10. International manned space exploration

Present state analysis (politics/social trends)

- Instability of Japan's presence and technical advantages in manned space activities due to the rise of emerging nations like China and India
- Intensified international exploration competition
- Importance of multilateral partnerships including Japan-US cooperation

Issues to solve = Outcomes to produce

- Stronger ties with ISS partners and development new partnerships
- Maintenance and improvement of Japan's international presence
- Industrial promotion through the dissemination of world's best scientific outcomes and acquired technologies

Output

- Strengthening of Japan's leadership and voice concerning deep space beyond the low-earth orbit by engaging in critical parts of international space exploration
- Japan's initiative for new international cooperation and rulemaking

Approach (draft)

- Proposal and implementation of Japan's space exploration plans based on collaboration with science exploration, scientific significance of mission, succession of JEM/HTV and other technological results, growth of private business operators in various fields
- Early demonstration of deep space replenishment technologies, manned space residency technologies, gravitational celestial body taking-off and landing technologies, and gravitational celestial body exploration technologies as technologies Japan has advantages and technologies to be developed because of their effects on other fields

III. 3. 11. Platform technologies to support development and operation of systems including satellites (e.g. tracking and operationtechnology, environment testing technology)

Present state analysis (politics/social trends)

- Space utilization including security is essential for the government and industry
- Expectations for the space industry are increasing as a growing industry in Japan

Issues to solve = Outcomes to produce

- Assurance of national security and industrial promotion
- Accomplishment of national space policy targets according to basic technologies supporting safe operation and ensuring development of satellites

Output

- Maintenance and operation of facilities and equipment for tracking and maneuvering satellites and acquiring data, and accomplishment of missions by maintaining and operating environmental test equipment and conducting environmental tests
- Improvement of efficiency in systems and tests through R&D of tracking technology and environmental test technologies
- Extensive use/social return of acquired environmental test technologies/equipment

Approach (draft)

- Maintenance and operation of facilities and equipment including antennas for tracking and maneuvering satellites and acquiring data
- R&D of tracking network systems
- Participation in rulemaking and investigation for maintaining frequencies of wireless stations in Japan and abroad, and maintenance and promotion of frequency band allocation to aerospace utilization fields through adjustments of frequencies with other wireless stations
- Maintenance and operation of installed environmental test equipment and conducting environmental tests
- R&D for mitigating vibration and heat/vacuum test conditions and improving test efficiency

III. 4. 1. Works to promote the industry and grow space utilization through Public-Private Partnership and the like

Present state analysis (politics/social trends)

- Space utilization is essential for the industry
- Expectations for the space industry are increasing as a growing industry in Japan

Issues to solve = Outcomes to produce

- Expansion of space utilization and industrial promotion

Output

- Contribution to creating new space related businesses with private business operators as the main player
- Creation of new businesses by means of the social return of R&D outcomes
- Contribution to fostering human resources critical for the space industry
- Provision of opportunities for space demonstration as independent businesses in private sectors

Approach (draft)

- Partnership type cooperation to promote business on even ground with various new private business operators in addition to conventional space related companies
- Acquisition of technologies leading to new space utilization
- Institutional reform including more flexible rules for handling intellectual property
- Use of private funds such as those entrusted or contributed to collaborative research from private sectors, and cooperation with financial institutions to promote investment to the space industry
- Transfer of know-how on joint use of rockets to private business operators intended to be independent operators by giving them opportunities for space demonstration

III. 4. 2. Maintaining and enhancing space industry platforms and scientific technology platforms for creating new value (including platforms to counter space debris and space solar energy generation)

Present state analysis (politics/social trends)

- Space utilization including security is essential for the government and industry
- Expectations for the space industry are increasing as a growing industry in Japan
- Instability of Japan's presence and technical advantages due to the rise of emerging nations like China and India and private business operators

Issues to solve = Outcomes to produce

- Assurance of national security, safe and secure society, extensive space utilization and industrial promotion, creation of world's best scientific outcomes and maintenance and improvement Japan's presence
- Maintenance and development of space industry and scientific bases in Japan

Output

- Development of new businesses and discontinuous technological innovation through challenging R&D to lead society including space debris measures and reusable space transportation system technologies
- Contribution to improving international competitiveness based on a long-term standpoint through R&D of space solar power generation system related energy transmission/distribution technology and liquid natural gas (LNG) promotion technology

Approach (draft)

- Technical demonstration of low cost debris removal services in collaboration with private business operators
- Investigation and planning of new satellite systems, and initial R&D and demonstration
- R&D of technologies for environmental control and life support, radiation protection, and access to gravitational celestial bodies in international space exploration, and those for observation and analysis of gravitational celestial bodies
- R&D of element technologies, and sensor, parts, component and system development techniques
- R&D of energy transmission/distribution technologies and LNG promotion technologies

Ⅲ. 5. Aeronautical science and technology

Present state analysis (politics/social trends)

- Significant growth of international aircraft markets
- Importance of the aviation industry as a growing industry in Japan

Issues to solve = Outcomes to produce

- Promotion of the aviation industry, strengthening of international competitiveness and sustainable development

Output

- Improvement of environmental adaptability and economics and safety of civilian aircraft, acquisition of greater share by Japanese private business operators in international joint development, and contribution to the development of completed aircraft business and accessory industry
- Improvement of international advantage in aviation science technology, and proactive contribution to international standardization
- Aircraft design technologies allowing the prompt and efficient development of aircraft

Approach (draft)

- R&D and technical demonstration of next-generation engine technologies, noise reduction fuselage technologies, accessory technologies, and technologies to increase aircraft utilization in collaboration with private business operators
- R&D and technical demonstration of system integration design technologies for silent supersonic aircraft based on low sonic boom design technologies, and airframe design integration technologies and electric aircraft technologies for drastically reducing CO_2 emissions from aircraft
- Significant improvement of numerical simulation technologies including computational fluid dynamics (CFD), and maintenance and improvement of fundamental technologies such as testing and measuring technologies and material evaluation technologies