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PERSPECTIVE ON FULL REUSABLE SSTO AEROSPACE PLANE RESEARCH AND DEVELOPMENT IN JAPAN

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Abstract—For the promotion of extended and diversified space activities in Japan, it is required to build immediately the technology bases capable of supporting such space activities and thereby to expand positively international cooperation as one of Japan's roles towards the world's prosperity of the 21st century. Especially, development of the manned space transportation system to and from lower earth orbit is the key issue, requiring an unprecedented approach. The Single Stage to Orbit(SSTO) Aerospace Plane is the unique answer to this issue. This paper will discuss the perspective on the research and development of the Space Plane in Japan. The topics will cover a long range R&D scenario and current activities of the related organizations in Japan.

1. INTRODUCTION

Viewing the 21st century with the consideration of the rapid progress and changes in national as well as international situations surrounding space activities, Japan's space policy was deliberated by the Consultative Committee on Long Term Policy under the Space Activities Commission in 1987. As stated in the report issued by the Committee [1], Japan's space development is to build immediately the technology bases capable of conducting autonomous space activities solely for peaceful purposes and thus to extend positively international cooperation as one of Japan's international roles toward the 21st century. The Committee recommended that Japan should endeavor to behave as a member of the kernel in space activities in the world in the beginning of the 21st century, and the Committee proposed the fundamental course of Japan's space development programs (cf., Fig. 1: Space activities in 21st century).

Promoting future space activities, development of "Space Infrastructure" and the evolution of manned space activities are the fundamental subjects, and above all, development of the space transportation system to and from lower earth orbit is the key issue. In accordance with the debates on Long Term Space Policy by the Consultative Committee, the Advisory Committee on the Space Plane was established under the Research and Development Bureau of Science and Technology Agency to deliberate the Japanese long-term R&D policy for the development of new space transportation systems, with a special emphasis upon the manned space plane. The Advisory Committee issued the Report in June 1987 [2]. Based upon the Report issued by the Advisory Committee, the perspective on Japanese Space Plane research and development is outlined in the following sections.

2. GOAL OF THE MANNED SPACE TRANSPORTATION SYSTEM IN JAPAN

To promote the future space activities, the development of the new-generation space transportation systems is the fundamental issue. Its significance and necessity are summarized as follows.

- Space transportation systems are the fundamental element of the Space infrastructure for the promotion of space activities.
- Such systems are indispensable to Japan's autonomous space activities.
- They improve global system survivability by eliminating the biased reliance on limited launch means.
- They provide the technology bases for the development of next-generation Hypersonic Transport.
- They serve as a Motive force to stimulate promotion of science and technology.
- They contribute to the growth of innovative human society.

Basic development concept for space transportation systems viewing technology bases in Japan is:

- To separate distinctly the development of a manned transportation and an unmanned cargo transportation is essential.

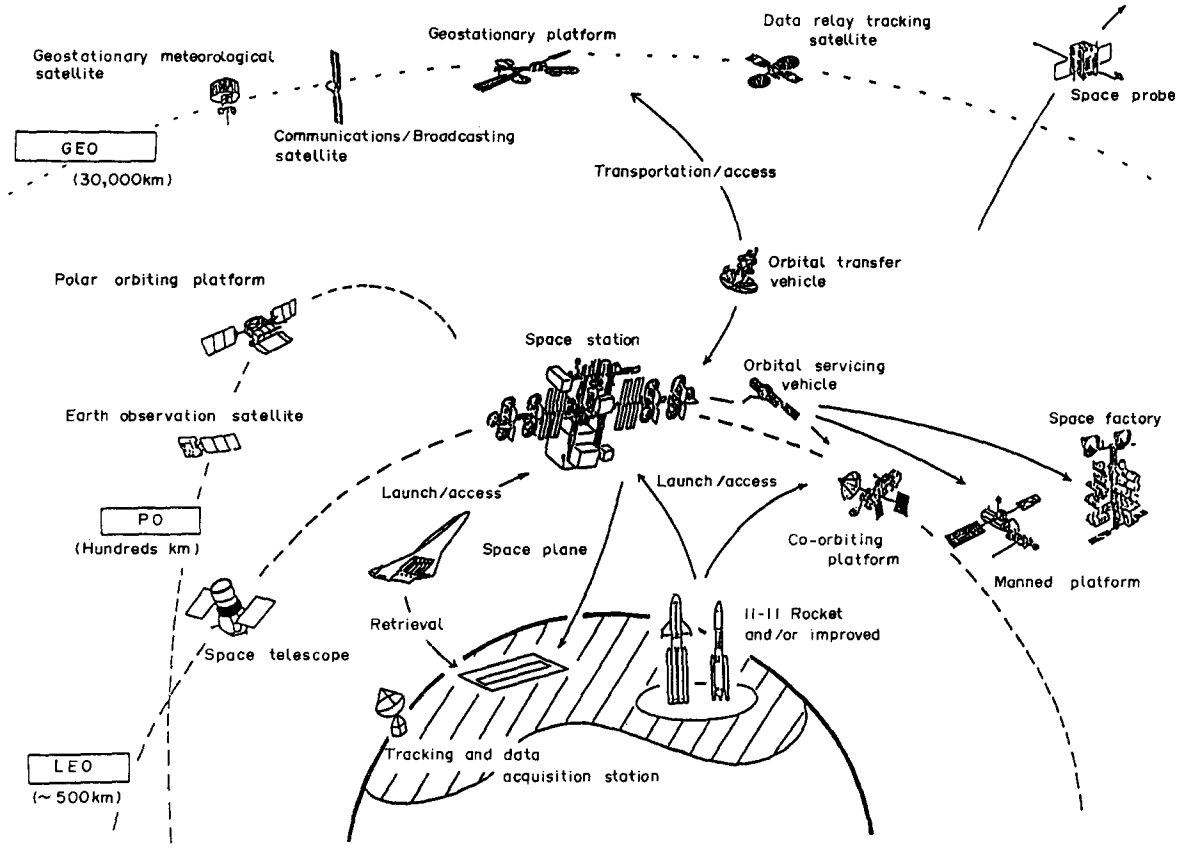

Fig. 1. Space activities in the 21st century.

- For a manned transportation system, the most important issue is the guarantee of safety, reliability, comfort and also to value the economic aspect, while for cargo transportation, on the other hand, to value payload fraction and the cost effectiveness for massive payload.

With these basic development concepts in mind, the goal of the manned space transportation system, i.e. the Space Plane, of Japan proposed to aim at a reusable winged vehicle of horizontal take-off and landing with sufficient reliability and operational flexibility as compared to an airplane, and to promote the research and development aiming at the preliminary operation of the experimental Space Planes in the beginning of the 21st century.

3. BASIC CONCEPT FOR PROMOTION OF RESEARCH AND DEVELOPMENT OF THE SPACE PLANE

Leading countries in space development are promoting the ambitious space policy and developing their activities with the recognition of the significance of the space activities to their prestige or socio-economic development.

Although Japan has not yet established the definite Space Plane program, the aerospace-related agency and national research institutes have been conducting the basic research works. For the promotion of research and development, it is of great importance to enhance and integrate the aerospace technology fields such as new materials, electronics and so forth, and to promote this as a large scale national project taking into consideration the improvement and establishment of basic technologies and flexibility of its operation. As for the international cooperation, however, it is necessary to consider the flexible association from the early stages with our great efforts to improve our own technologies in order to secure Japan's design authority.

Basic plan for Space Plane research and development proposed by the Ad-hoc Committee is schematically outlined in Fig. 2. The program consists of a planning phase, a technology readiness verification phase and a prototype development phase to promote the research and development based on the time-phased scenario to attain the goal of experimental operation to commence in the beginning of the 21st century. The outlines of the respective phases are as follows.

Planning phase (present stage)

- To advance key element technologies.
- To start the preliminary design of experimental planes to be test-flown in the verification phase.

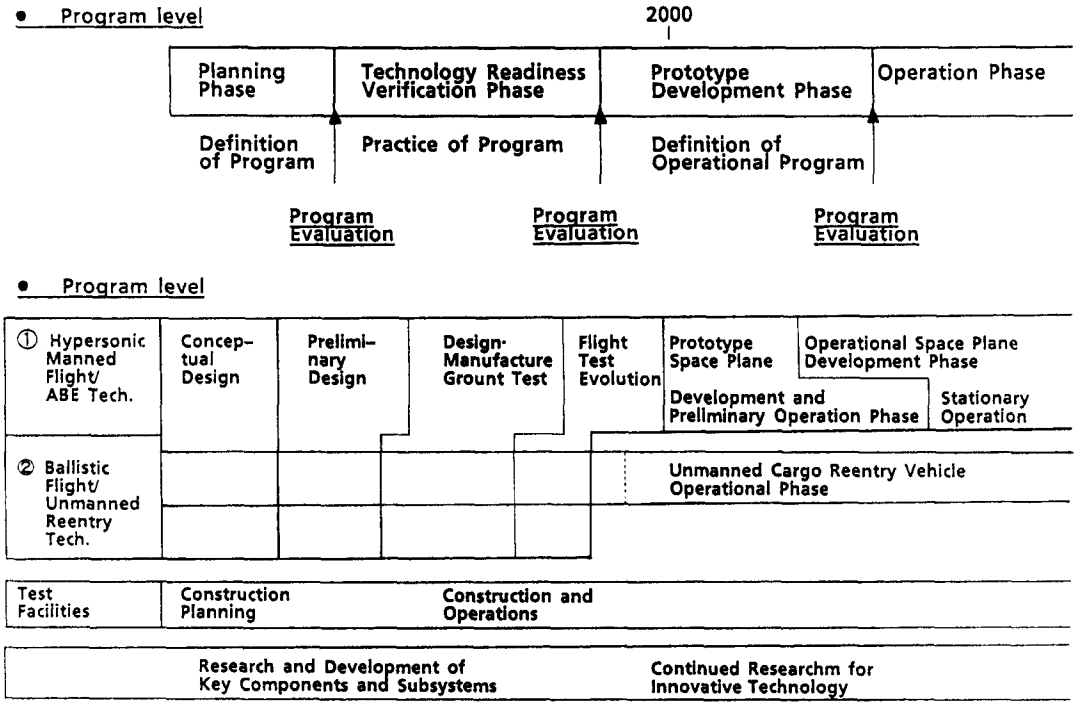

Fig. 2. R&D Scenario on the Space Plane in Japan.

During this phase, the Space Activities Commission will define a long-range national program including development of test sites and facilities.

Technology readiness verification phase

- To verify the technology readiness required for the prototype development through test flights of the experimental planes, such as (1) hypersonic manned flight technology and airbreathing engine, (2) unmanned re-entry technology with emphasis on ballistic flight and deorbiting.

Experimental space plane development phase

- To start the experimental space plane development based on the aerospace and related technology established in the previous phases.

The program milestone in the Space Plane development is defined as the preliminary operation of the X-plane toward the beginning of the 21st century, followed by development of a fully operational space plane.

4. TECHNOLOGICAL STATE OF THE ART AND ISSUES TO BE RESOLVED

The Space Plane exhibits both aspects of an aeroplane and a space vehicle, i.e. Space Plane takes off from a runway horizontally, accelerates and ascends up to the limiting height to utilize the atmosphere as an aeroplane. Afterwards, it accelerates and ascends continuously using rocket engines to reach the lower earth orbit. In orbit, it acts as a space vehicle to supply or exchange crew members after rendezvous/docking to the space station or to another space system. After the mission completion, it deorbits and re-enters the atmosphere and lands on the runway where it touches down as an aeroplane. For such a system configuration to be feasible, advanced technology breakthroughs will be required, cf. [3]. The key objectives are:

- Airbreathing engines—high specific impulse, high thrust to weight ratio.
- Integrated engine and airframe.
- Reductions in structure weight, aerodynamic drag.
- Ultra-high temperature materials for thermal protection system.
- Design and optimization of vehicle components.
- Advanced control technology.
- Manned hypersonic flight experience.

As for the development/construction of test facilities including flight test sites required for Space Plane research and development, the Ad-hoc Committee on Facilities for Aerospace R&D was established under The Bureau of Research and Development, Science and Technology Agency in January 1988 and the basic scenario on the development of facilities are currently being studied.

5. CURRENT ACTIVITIES OF RELATED ORGANIZATIONS

Figure 3 illustrates schematically the current activities of related organizations and the decision flow chart of

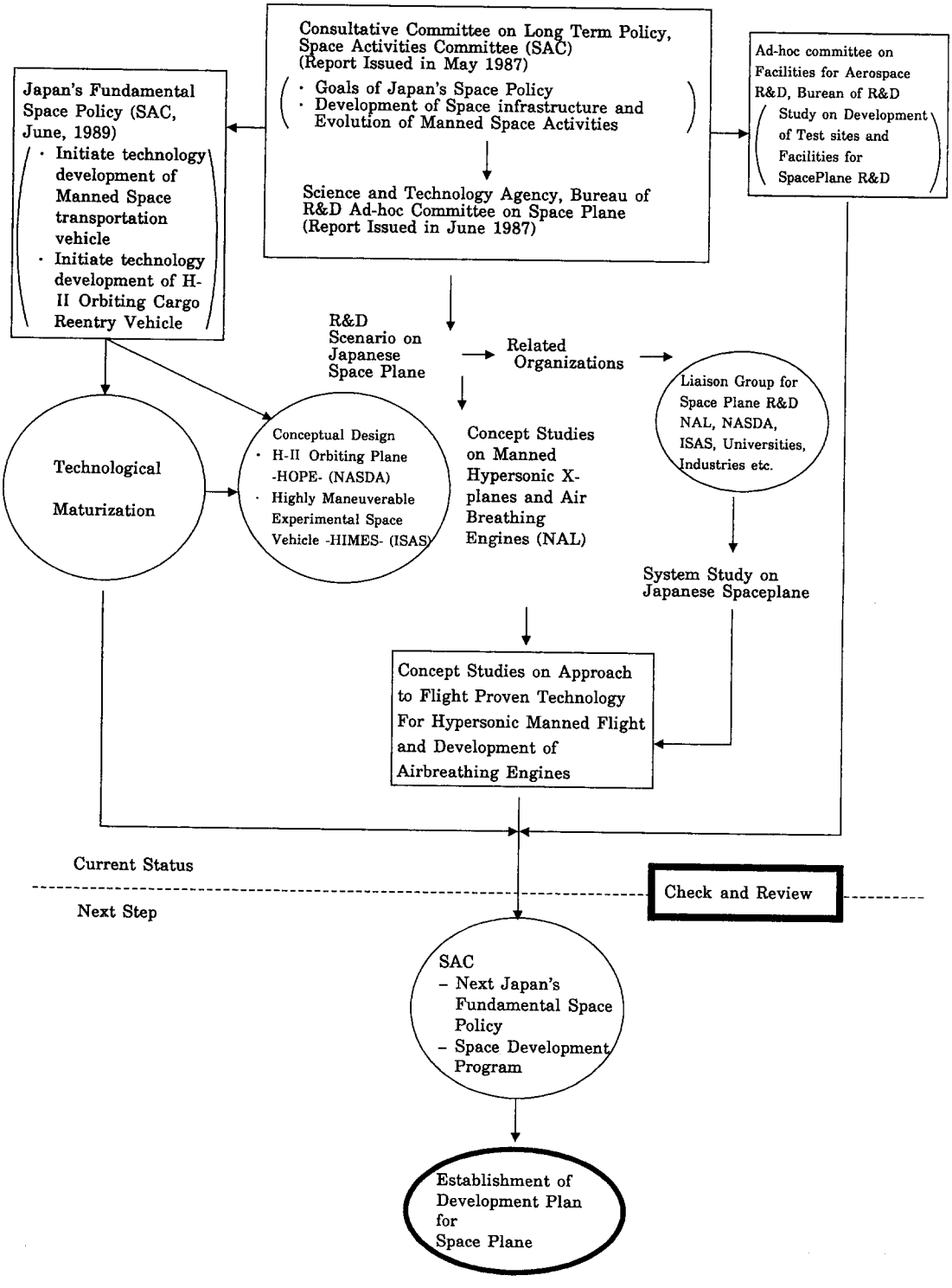

Fig. 3. Related organizations and decision flowchart.

Fig. 4. H-II Orbiting Plane (HOPE).

Fig. 6. HIMES—Highly Maneuverable Experimental Space Vehicle.

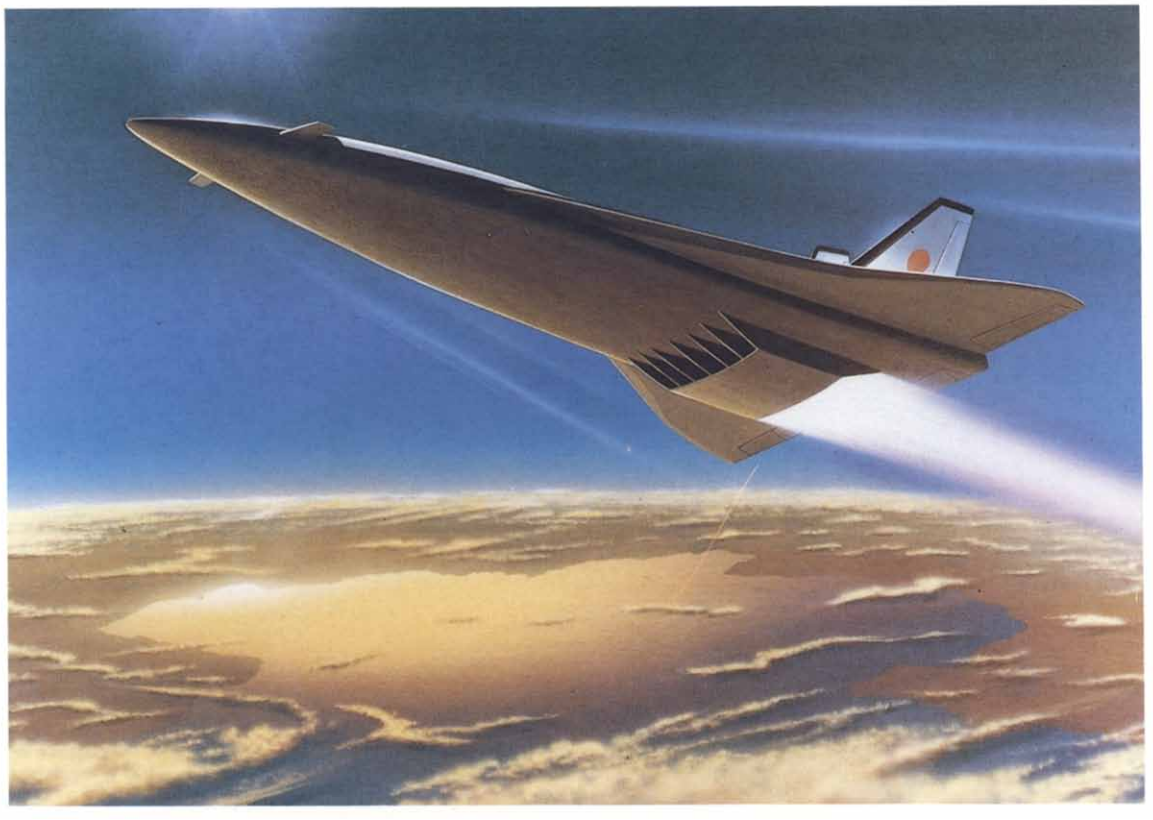

Fig. 8. Concept of single stage to orbit space plane.