

The Formation of Korean Satellite Development Program: The Case Study of SaTReC and SaTReC-I*

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Introduction

"The Sky is the Limit"

This is the sentence on the rock in front of KAIST Satellite Technology Research Center (SaTReC). This sentence has been used since about the 1900s, and it means that there is no limitation. This sentence clearly shows the track of SaTReC from the beginning and until now. Also, it shows the history and the ambition of SaTReC and the history of the Korean satellite development program. SaTReC, established as the first Korean space specialized institute in 1989, launched the first Korean satellite, KITSAT-1. Based on the successful launches of KITSAT-1 and KITSAT-2, the Korean satellite has developed and expanded its boundaries to other research institutes, the government, industry, other countries, and the public. With SaTReC, the Korean satellite development program¹ started.

Nowadays, there are many institutes and companies related to satellite development in Korea. However, SaTReC still is an essential part of the history of the Korean satellite development program. So, this paper examines the Korean satellite development program using a case study of SaTReC. It divides the history of SaTReC and Korean satellite development programs into four periods based on the boundary of the Korean satellite development program: 1989-1993, 1994-1999, 2000-2005, and 2006-2013.² Doing so will show how the Korean satellite development program

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* This paper has been developed based on the master's thesis in 2012 (Chung Seungmi, "Looking into SaTReC to track Korean space development: From the only one to one of them," Master's thesis, KAIST, 2012). The framework of the analysis was modified and more evidence and analyses were added.

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¹ In this paper, the Korean satellite development program included the satellite development program in the history of Korean space development in official government documents.

² The period after 2013 is difficult to study in historical papers because it is too recent. So, this paper covers the history between 1989-2013.

was established in Korean society and expanded its boundaries.

What transpired in the Korean satellite development program during the four periods discussed here shows interesting differences than those suggested by the conventional understanding of the space program. The space program is usually considered a big science. Big science is typically characterized by the government's heavy involvement due to the broad scope of this field and the amount of funding needed.³ As Song Sung-Soo noted, in the Korean context, not only big science but also most science and technology areas have developed through the strong involvement of a government intent on industrialization. The government has intervened actively even in private R&D.⁴ Lee Chang Jin, particularly during the public hearing on the formation of national space development policy, emphasized that one of the significant characteristics of the Korean space program is a solid government-led program.⁵ Indeed, the space program can be considered a government-led project because the effort generally needs enormous monetary and human resources and continuous political support. However, this paper reveals a notable difference from those preconceptions about the role of the government in the satellite development program. Although the Korean Government funded the Korean satellite development program, the Korean satellite development program was initially performed not by the government but by an autonomous research group, SaTReC. The government started to provide leadership much later.

Research about SaTReC has been performed by Tae Euikyung, An Hyoung Joon, and Lee Seorim. Tae analyzed the process of obtaining and improving the satellite technology of SaTReC and understood the change of SaTReC's position in Korean society as the conflict between two national R&D policies, "government-led research" and "autonomous research." However, Tae's research focused on the change of SaTReC's itself. It did not cover the role of SaTReC in the overall Korean satellite development program. Technology acquisition and improvement are the primary subjects of the analysis. Although it mentioned that SaTReC contributed to the diffusion of space technology unintentionally, it did not provide a specific analysis.⁶

³ W. D. Kay, *Defining NASA: The Historical Debate over the Agency's Mission* (New York: State University of New York Press, 2005), 118-121.

⁴ Song Sung-Soo 송성수, "Han'guk Gwahakgisuljeongchaekkeui teukseonge gwanhan silonjeok gochal 한국 과학기술정책의 특성에 관한 시론적 고찰 (A Study on the Characteristics of Science and Technology Policy in Korea)," *Journal of Science & Technology Studies* 과학기술학연구 2:1 (2002), 63-83.

⁵ Lee Chang Jin 이창진, *Gukgawujugaebaljeongchaek sulipeul wihan gongcheonhoi 국가우주개발정책 수립을 위한 공청회* (Public Hearing for Establishment of National Space Development Policy) (Ministry of Education, Science and Technology, November 25, 2011).

⁶ Tae Euikyung 태의경, "KAIST Ingongwuseongyeongusenteoeui wisung gisul seupdeupgwa gaeseon gwajeong gochal 카이스트 인공위성연구센터의 위성 기술 습득과 개선 과정 고찰 (A Study

An analyzed the history of the Korean space program from 1958-2013 and argued that nationalistic rationales had driven the Korean space program. Specifically, An argued the 1980s, when the Korean satellite program started, is the era of economic security and introduced SaTReC as one of the main players of space development in the period. Although he studied the conflict between Korea Aerospace Research Institute (KARI) and SaTReC, he did not analyze it profoundly. An considered the conflict as the process to make a comprehensive national space program.⁷

Lee, a founding member of SaTReC and KARI researcher, analyzed the national space development policy system by applying the multi-stream framework. Lee pointed out that SaTReC and KARI were fundamentally different groups represented by the characteristics of "pioneering and innovation based upon devotion" and "striving for efficiency and success carrying the burden of accountability,"⁸ respectively. However, SaTReC's case was one of several case studies of the overall Korean space program in the research. The relationship between KARI and SaTReC and the impact of the case of SaTReC were not analyzed in detail.⁹

Although there is some research about SaTReC, some of them analyzed the case of SaTReC in a macro version of the overall Korean space program. They did not provide the specific interaction between SaTReC's case and the Korean satellite development program and society. Or, another study focused on SaTReC itself and missed the relationship between SaTReC and the larger society. So, by concentrating on SaTReC and its relationship with society, this research shows how the Korean satellite development program expanded its boundary and settled its position in society.

The Birth of the Korean Satellite (1989-1993)

Although the space program started much later in Korea than in other advanced countries, the Korean space program has had diverse experiences over the last three decades. SaTReC demonstrates the transition and evolution of the Korean satellite development program. SaTReC was established with the social needs of the space program and has experienced many changes, including its roles and position that reflect changes in Korean society and both government needs and circumstances.

of the Process of Obtaining and Improving Satellite Technologies at KAIST SaTReC)", *The Korean Journal for the History of Science* 한국과학사학회지 37:1 (2015), 85-117.

⁷ An Hyoung Joon, "National Aspirations, Imagined Futures, and Space Exploration: The Origin and Development of Korean Space Program 1958-2013," (Ph.D. dissertation, Georgia Institute of Technology, 2015), 120-162.

⁸ Lee Seorim, "Space Development without a Dream: Implications of an Industry Focused Space Policy in Establishing a Sustainable National Space Program," (Ph.D. dissertation, KAIST, 2018), 49.

⁹ *Ibid.*, 24-51.

(1) Prehistory of the Korean space program

Before the presentation of the case study, a brief pre-history of the Korean space program is necessary. The Korean Government started to take an interest in the space program as early as the 1950s. Its first action was to join the International Telecommunication Union (ITU) in 1952. Then Korea entered into various international agreements on space, including a space agreement settled by the United National Committee on the Peaceful Uses of Outer Space (UN COPUOS).¹⁰ In addition, the Korean Government acquired a loan from the Export-Import Bank of the U.S. to establish a domestic satellite base station and performed rocket research beginning in the 1950s.¹¹ The Korean Government also paid attention to public relations with the production of *Gwahakgisulyeongam* (The Yearbook of Science and Technology) and *Daehan News*.¹² Through these activities, Korea was able to forge ahead with further preparation for their space program.¹³

¹⁰ Ministry of Science and Technology (MOST), 2006 *Woojugaebal Baekseo* 2006 우주개발백서 (2006 White Paper of Space Development) (MOST, 2006); Other international agreements include: The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (1967); Agreement of the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968); the Convention on International Liability for Damage Caused by Space Objects (1972); and the Convention on Registration of Objects Launched into Outer Space (1981).

¹¹ Ministry of Posts and Telecommunications (MPT), *Wujutongsineul wihan segye munseon tongsin juwan chonghoeui*, 1969-1971 우주통신을 위한 세계무선통신주관청회의, 1969-1971 (World Administrative Radio Conference for Space Telecommunications, 1969-1971), National Archives (BA0109460); Ministry of Foreign Affairs and Trade (MOFAT), *Wujuhang'gongsaeui guso wujuhang'gongsaeui guiwan mit woigigwone balsadeoin mulcheeui hwoisue gwanhan hyeobjeong* 1969. 4. 4 우주항공사의 구조 우주항공사의 귀환 및 외기권에 발사된 물체의 회수에 관한 협정 1969. 4. 4. (Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 1969. 4. 4), National Archive (CA0006396); Ministry of Finance and the Economic Planning Board (MFE), *Wiseongtongsin jigugukgeonseol chagwan gwangyecheon* 1968-1968 위성통신지구국건설 차관관계철 1968-1968 (Document about Establishment of Satellite Communication Ground Station, 1968-1968), National Archives (BA0146645); MFE, *(The U.S. EXIM) Wiseongtongsin jigugukgeonseol chagwan gwangyecheon*, 1968-1968 (The U.S. EXIM) 위성통신지구국건설 차관관계철, 1968-1968 (Document about Establishment of Satellite Communication Ground Station, 1968-1968), National Archives (BA0146657).

¹² *The Yearbook* started with a mention of space development in 1969. *Daehan News* showed news of satellite and space development from 1957. Initially, it covered foreign space issues, and latter extended its coverage to domestic space development. As such, it signaled the intention of the Korean Government to educate the public about space and expose them to space development.

¹³ International activities that the Korean Government undertook in that period were not for space development directly, but rather for the increment of national power and extension of national influence. It is undeniable that it became the basis for Korean space development.

The practical preparation for the Korean space program began in the 1980s. Successful economic growth and confidence in Korea's independent research capability led to the discussion of the Korean space program. Early active promotion of a space program started with the establishment of a committee for aerospace industry policy by the then ruling party, *Minjujeonguidang* (Democratic and Justice Party). This committee conducted R&D and industry development in the aerospace industry and basic research according to the Aerospace Industry Promotion Act in 1987.¹⁴ The Act laid the groundwork for the Korean space program and, in particular, a specialized aerospace research institution. The 1988 Seoul Olympic Games brought further calls for space research, as reception in TV fringe areas during preparation for the Games made communication and broadcasting satellite projects a major public issue. Indeed, a communication and broadcasting satellite became part of the electoral platform for the presidential candidate Roh Tae-woo in the 1987 election.¹⁵

These movements further activated the discussion about establishing a specialized aerospace research institution to perform space development. Although the Institute of Space Science and Astronomy (ISSA) was established in 1986, it was oriented on the Korean National Astronomy Observatory (KNAO) and focused on space science, not space engineering. As the Space Engineering team in 1987 started the basic research for scientific rocket development and trajectory computation of satellites, it was not for the development of space objects directly. The goal of the research was mainly to prepare for the future when Korea would operate space objects.¹⁶ So, establishing a specialized aerospace research institution to perform space development was tried as part of the Aerospace Industry Promotion Act. The Act stated that the government could establish a comprehensive or specialized research institution for more efficient aerospace research. Setting up a space research institution started with the preparatory process that founded KARI in 1988. The Ministry of National Defense (MND) and the Ministry of Science and Technology (MOST) tried to take active control of the institute. The final proposal for the establishment of the space research institute was approved in early 1989.¹⁷

¹⁴ Lim Dal Yeon 임달연, *Han'gukhang'gongwujusa* 한국항공우주사 (The History of Korean Aerospace) (Goyang: Korea Aerospace University Press, 2011), 439-447; An Hyoung Joon (2015), *op. cit.*, 114-116.

¹⁵ MPT, *Chesinbaekseo* 채신백서 (White Paper of Postal Service) (Seoul: MPT, 1991); KT Wiseongsaeobteam KT 위성사업팀 (KT Satellite Project Team), *Mugunghwa Wiseong 3ho Baekseo* 무궁화위성3호백서 (White Paper of KOREASAT-3) (Seoul: KT, 1999).

¹⁶ Space Engineering team was merged to KARI and the rocket research of Space Engineering team continued in KARI. The committee of KASI's 40 years history, *Han'gukcheonmunyeonguwon 40nyeonsa* 한국천문연구원 40년사 (The 40-years History of KASI) (Daejeon: KASI, 2014), 86-88.

¹⁷ Ministry of Commerce, Industry and Energy (MCIE), "Hang'gongwujusaneobgaebalchokjinbeob (I) 1988-1988 항공우주산업개발촉진법 (I) 1988-1988 (Aerospace Industry Promotion Act (I), 1988-

(2) The Establishment of SaTReC (1989-1993)

In the late 1980s and early 1990s, the Korean government recognized the necessity of the space program. The report published in 1990 revealed the Korean Government's rationales for the active promotion of the space program. For example, the space program was considered necessary for survival in the future worldwide race in science and technology, independence in the military sector, and a greater national vision of a science-advanced country. Progress of science and technology, national security, social stability, and national pride were mentioned as positive by-products of space development. Although commercial benefits were mentioned, they remained merely part of the long-term vision and limited to domestic needs.¹⁸ The following comment by KARI nicely captures these Korean space program rationales: "If one only emphasizes the practical aspects of space development, persuasive argument for the validity of space development, which needs enormous budget and strong political support in the long run, cannot exist."¹⁹

The Korean Government needed the development of broadcasting and communication satellites. However, the need for much preliminary research made it difficult for Korea to develop commercial satellites directly. After President Roh was elected, "Comprehensive Plan of Communication and Broadcasting Satellite project" was finalized, and KOREASAT-1 project started. The Korean Government operated two satellite programs, the Leased satellite project, and the KOREASAT project. However, both were projects for "securing" and "operating" satellites, not for "developing" satellites.²⁰ The institute for developing space technology was needed.

The establishment of SaTReC was supported not only by the social needs for the space program but also by the government's needs for university research. In the late 1980s, perceiving the necessity of this basic research, the Korean Government reinforced the research functions of universities. Basic research funding of universities

1988)," National Archives (BA0786617); MCIE, "Hang'gongwujusaneobgaebal chokjinbeob (II) 1988-1988 항공우주산업개발촉진법 (II) 1988-1988 (Aerospace Industry Promotion Act (II), 1988-1988)," National Archives (BA0786619-BA0786621); KARI, *Han'gukhang'gonwujuyeyonguwon 10nyeonsa 한국항공우주연구원 10년사* (Korea Aerospace Research Institute Decennial History) (Daejeon: KARI, 2001), 66-68.

¹⁸ KARI, *Wujugaebaleul Wihan Haksimgisul Yeongu mit Gyeowoiksulib 우주개발을 위한 핵심기술 연구 및 계획수립* (Research on Essential Technology and Planning for Space Development) (MOST, 1990).

¹⁹ *Ibid.*, 399.

²⁰ Tae Euikyung, "KAIST In'gongwisungyeongusentereui sohyungwisungjejak gisulhakseup, 1989-1999 카이스트 인공위성연구센터의 소형위성제작 기술학습, 1989-1999 (The Study of Micro-Satellite Manufacture Technologies by KAIST SaTReC:1989-1999)," (Master's thesis, Seoul National University, 2014), 16.

from 1983 to 1986 totaled only KRW 28.9 billion during three years. It increased to KRW 33 billion in 1988 and KRW 49.3 billion in 1990. With the enactment of the Promotion Act of Basic Science Research and implementation of the Science Research Center (SRC)/Engineering Research Center (ERC), universities became the main actors for Korean science and technology research.²¹

At the center of establishing SaTReC was Professor Choi Soon Dal at KAIST, who is called the founding father of SaTReC. With his background in Jet Propulsion Laboratory (JPL), Dr. Choi came to appreciate the need for space development and satellites while working at the Korea Science and Engineering Foundation (KOSEF). After he returned to KAIST as a professor, he chose satellite research as his primary research topic. Pursuing his dream of developing a Korean satellite, he discussed a study abroad program with professors of the University of Surrey in the U.K. Successful negotiations with the University of Surrey and funding support from GEC Marconi helped Dr. Choi promote his plan. The announcement of the ERC program was also a positive opportunity for Dr. Choi and SaTReC.²²

SaTReC was selected as the first ERC of KOSEF and began its research in March 1990, although the first cohort of students had already left for the study abroad program in September 1989.²³ The Korean Ministry of Postal and Telecommunication (MPT) and MOST decided to support SaTReC as a national research project. Since SaTReC was established within the university, it maintained complete independence in conducting its own research.²⁴

Dr. Choi wanted SaTReC to become a research institute like the Institute of Space and Aeronautical Science (ISAS) at the University of Tokyo and JPL at Caltech. Those research institutes were university organizations devoted to basic research. SaTReC took advantage of being a university research institute and focused on developing a small satellite as technology catch-up as well as basic research driven by their intellectual curiosity rather than limiting its scope to commercial satellite development.²⁵

SaTReC's focus on basic research is revealed from its research projects in the early

²¹ Bak Hee Je 박희제, "Han'guk daehakeseoeui gwahakyeongueui seonggyeokgwa byeonhwa: 1980nyeondae ihu yeongugaebalbi heuleumeul jungsimelo 한국 대학에서의 과학연구의 성격과 변화: 1980년대 이후 연구개발비 흐름을 중심으로 (Characteristics and Transformation of Korean Academic Science: Focusing on the Trend of Academic R&D Expenditure since 1980s)," *Korean Journal of Social Theory* 사회이론 30 (2006), 225-238.

²² Choi Soon Dal 최순달, *48nyeonhu Yi Aineun Woorinara Choichoeui Ingongwiseonguel Ssoah Olipnida* 48년 후 이 아이는 우리나라 최초의 인공위성을 쏘아올립니다 (This Boy Would Launch the First Korean Satellite after 48 Years) (Seoul: Haenggan Punggyung, 2005), 198.

²³ SaTReC, *Woorineun Byuleul Ssoatda* 우리는 별을 쏘았다 (We Launched Star) (Seoul: Mihacksa, 1993), 17-23; KOSEF, (*Wusuyeongusenteo*) *Yeongugwaje moklok* (우수연구센터) 연구과제 목록 (Science and Engineering Research Center) The List of Research Project (KOSEF, 1996).

²⁴ STEPI, *Yeongugaebal Seonggongsalyeo Bunseok (I)* 연구개발 성공사례 분석 (I) (In Search of Best Practices in Successful R&D Projects in Korea (I)) (STEPI, 1997), 33-34.

²⁵ Choi Soon Dal, interview by author (December 7, 2010).

1990s. The research projects in 1990 were mainly concerned with establishing a ground station and support for study abroad programs. However, the following year SaTReC did not concentrate its efforts only on developing KITSAT-1 and related research. SaTReC could go beyond the development of KITSAT itself and choose to study more varied topics relevant to KITSAT. Engineering major professors developed satellites and other major professors including business, industrial design, biology, and forest resource participated in SaTReC. They operated projects that were not directly related to satellite development. It is notable that SaTReC did not confine its work to satellite development but also conducted basic research on social and economic aspects of space. In 1990, Dr. Chung Won-Il worked on "the research about space biology" project with KRW 10 million from the ERC budget. Dr. Yu Pyeong-Il operated "the effect of satellites on industries and economies" project with a doctoral student with KRW 5 million. The budget was also from the ERC project. The basic research, including basic physics, economics, and biology, continued in SaTReC. In addition, SaTReC undertook many other projects on their own initiative and contracted out small sub-projects to other research institutes.²⁶

SaTReC was an emblematic research institute for the space program in the early stage of the Korean space policy. SaTReC became the main organization for satellite development. At the end of 1992, the number of SaTReC participants was 160. Among them, SaTReC researchers and staff only account for 37, and KAIST professors totaled 16. Others were from other universities, research institutes, and companies.²⁷ The researchers from other institutes joined in the Research part of SaTReC, and SaTReC trained them in satellite technologies as the main organization.

SaTReC distributed several component projects to other research institutes and private companies to coordinate this project. KARI participated in developing the Mechanical Structure of Satellite and the space environment test of the satellite. Korea Astronomy & Space Science Institute (KASI) participated in research in space science experiments, and the Radio Research Laboratory (RRL) cooperated with SaTReC in developing the technologies for ground station operation and over-the-air reception devices. The System Engineering Research Institute (SERI) participated in the KITSAT project in the processing of image data received from satellites, the

²⁶ KAIST, '96 *Gigwan Goyu Saeob Bogoseo*, *Ingongwiseongyeongusenteo* '96 기관 고유 사업 보고서, 인공위성연구센터 ('96 report of Institutional Program, SaTReC) (KAIST, 1997), 118-119; SaTReC, '96 *nyeondo Yeongugyeolgwa Yoyakjib* '96년도 연구결과 요약집 (The summary of '96 research result) (SaTReC, 1996), 15-19; SaTReC, *Saeobsiljeokbogoseo* 90.4-92.9 사업실적보고서 90.4-92.9 (The report of Result, 90.4-92.9) (SaTReC, 1992).

²⁷ The members who participated in SaTReC's project: 16 KAIST professors, 1 POSTECH professor, 2 Chungnam National University professors, 1 Sungkyunkwan University professor, 1 Yonsei University professor, 1 Dankook University professor, 2 Seoul National University professors, 16 KARI researchers, 22 Radio Research Laboratory (RRL) and the System Engineering Research Institute (SERI) researchers, 58 graduate students from KAIST and other universities, 37 SaTReC members, 3 Samsung Advanced Institute of Technology (SAIT) researchers.

earth exploration part, and the Electronics and Telecommunications Research Institute (ETRI) in the communication payload part.

Cooperation with companies was made in manufacturing rather than research. Companies made the parts of satellite that SaTReC could not manufacture due to insufficient equipment based on the blueprints of SaTReC. Several companies such as Samsung Aerospace Industries, Samsung Electronics, Daedeok Electronics, and Chungbuk Electronics assisted in satellite manufacturing. In this process, SaTReC transferred technologies of designing and manufacturing satellite RF systems to Samsung Electronics and satellite manufacturing technologies to Goldstar, Daewoo Telecom Co., Ltd., Hyundai Electronics, and Goldstar Information & Communications. Indeed, Samsung Electronics signed a contract with SaTReC for joint research and development of KITSAT-2 on November 2, 1992.

Cooperation with industries was further expanded as the KITSAT-3 project started. In February 1995, Hyundai Electronics dispatched eight researchers to SaTReC to participate in the KITSAT-3 project. Halla Heavy Industries also exchanged a cooperation agreement with SaTReC in September 1996. Based on the contract, SaTReC decided to take over the machining of the machine structure of KITSAT-3 at Halla Heavy Industries. The development of subsystems was also operated with the cooperation of industries. Samsung Electronics developed large-capacity memory, Halla Heavy Industries developed mechanical structure of satellite, and Sunny Electronics Corp. manufactured generators for satellites. Through the cooperation with research institutes and industries, SaTReC expanded the Korean satellite development program to the network around SaTReC.²⁸

That was possible because SaTReC received funds directly from the funding organizations such as KOSEF, MPT, and MOST. As the lead organization, it had more autonomy and independence to select research topics and implement them. In addition, since SaTReC was a university research institute and there were no other specialists who had more expert knowledge on satellites, SaTReC's research could maintain its independence and research credibility.²⁹

At this time, KARI was not a competitor of SaTReC as KARI's main research field was not satellite development but rocket development. The establishment plan of KARI mentioned satellite development in the middle range plan after 1997. In the beginning, the goal of KARI was to construct a research foundation through rocket development, construction of launch pads and tracking stations, and evaluation of

²⁸ KAIST (1997), *op. cit.*, 118-123; SaTReC (1992), *op. cit.*

²⁹ SaTReC, *Silheomyong Sohyung Ingongwiseong Gaebal Yeongu (I-III)* 실험용 소형 인공위성 개발연구 (I-III) (Development Study of a Small Experiment Satellite (I-III)) (KTA, 1991-1993); SaTReC, *Gwahakgisul Silheomyong Sohyung Ingongwiseong Gaebal Yeongu (I-IV)* 과학기술 실험용 소형인공위성 개발 연구 (I-IV) (Development Study of a Small Satellite for Science Technology Experiment (I-IV)) (MOST, 1991-1994).

purchasing of broadcasting and communication satellites. The research areas of the two institutes were different and they had a supportive relationship until the end of 1992.³⁰

The role of the Korean Government was minimal in the first period. Although the Korean Government prepared the Korean space program's legal and social bases, including the Aerospace Promotion Act, the government only funded space development projects. It did not directly control and manage the Korean satellite development program. SaTReC's projects were not government-led research projects where the government decided the research topic and then searched the research institute, but rather independent research projects where the researcher decided the research topic and then searched for the funding source.³¹ In this case, the government could not intervene in the research specifically. Although the KITSAT project was decided as a national project of MOST and MPT, MOST could only change the satellite launch schedule and add some payload for scientific experiments in KITSAT. The change of the size of the satellite, which MOST wanted, was not accepted.³² This shows the leadership of the KITSAT project was not on the Korean Government but on SaTReC.

SaTReC occupied a unique place in satellite development. SaTReC was an autonomous group in terms of Korean satellite development ostensibly.³³ The mid-term and long-term plans for the Korean space program did not exist in the first period. There was just a specific organization in place to perform research autonomously. SaTReC performed varied functions in its first period, including research, planning, managing, and advertising. Dr. Choi Soon Dal, SaTReC's founder, planned the KITSAT-1 project, and various professors, students, and researchers then collaborated to build the KITSAT series satellites with Dr. Choi. SaTReC managed the individual satellite projects as the head organization and took on the mission of promoting the overall satellite development program. The absence of other institutes necessitated the multiple functionalities of SaTReC. SaTReC was a hub of Korea

³⁰ KARI, *KITSAT Gujo, Yeoljeo mit Hwan'gyengsiheom Yeongu (I-IV)* KITSAT 구조, 열제어 및 환경시험 연구 (I-IV) (Structural and Thermal Control and Environmental Test of KITSAT (I-IV)) (MOST, 1991-1994); Korea Institute of Machinery and Material (KIMM), *Hang'gongwujuyeon-guso Seollibgyehwoik* 항공우주연구소 설립계획 (The Establishment plan of KARI) (Daejeon: KIMM, 1989), 4; Tae Euihyung (2014), *op. cit.*, 70-73; KARI, *Han'gukhang'gong-wujuyeuonguwon 20nyensa* 한국항공우주연구원 20년사 (20 years History of KARI) (Daejeon: KARI, 2010), 26-31.

³¹ Tae Euihyung (2014). *op. cit.*, 112.

³² *Ibid.*, 96-97.

³³ Park Sung Dong 박성동, interview by author (November 22, 2011); Anonymous (KARI researcher), interview by author (March 29, 2011); SRC-ERC, NRF, "SERC," <http://www.src-erc.or.kr/> (accessed July 29, 2021); After the selection as the ERC, KOSEF, now NRF, does not touch selected projects until the mid-evaluation.

satellite development and established the relationship between government and university, university and industry, university and research institute, and universities. SaTReC broadened the basis of Korean satellite development through seminars introducing satellite-related advanced technologies and advanced foreign technologies, expert seminars, and policy discussions every two months held jointly with the Korea Society of Satellite Technology. In addition, the researchers who were educated in SaTReC moved to research institutes including KARI, and the Agency of Defense Development (ADD), and industries including Samsung Aerospace Industries. The satellite development technologies of SaTReC spread to other institutes. SaTReC was the hub of the Korean satellite development program.³⁴ Some scholars indicated that the later project KOMPSAT-1 became the first government-led Korean space program.³⁵ Their observations confirm my claim that the Korean Government did not lead the Korean space program at the start. Like this, the KITSAT project by SaTReC was the starting point of the Korean satellite development program. But it was not government-led, and the Korean satellite development program was limited around SaTReC.

Opening the Korean Satellite to the Government and KARI (1993-1999)

After the successes of KITSAT-1 and KITSAT-2, SaTReC extended its research fields. This seemed to undercut the governmental policy to operate a government-led space program through KARI. By the same token, the tension between these two organizations had increased and began to jeopardize SaTReC's position. However, Korean society and public opinion did not change much in this period. The 1995 KARI report on the long-term planning in space policy presented the rationales for

³⁴ Yu Pyeong-Il 유평일 “Je11jang Wuribyul wiseonggaebalsaeobeui seonggongjecok chujin-Inleokyangseongul jungsimeuro han singisulhwoikdeuk jeonlayk 제 11장 우리별 위성개발의 성공적 추진-인력양성을 중심으로 한 신기술 획득 전략 (Chapter 11 The Success of KITSAT development- The strategy to acquire new technology based on nurturing human resource),” in STEPI, *Yeongugaebal Seonggongsalyeo Bunseok (I)* 연구개발 성공사례 분석 (I) (Analysis of Successful Case of Research and Development (I)) (STEPI, 1997), 347-349; KAIST (1997), *op. cit.*, 118-123; SaTReC (1992), *op. cit.*

³⁵ Kim Gyeong-Hui 김경희, “Wuribyul wiseong guknae wujugaebalgunyaecui ssiat 우리별 위성 국내 우주개발 분야의 씨앗 (The Seed of Korean Space Development, KITSAT),” *Satellite Communications and Space Industry* 위성통신과 우주산업 13:1 (2006), 40-45; Choe Hae-Jin 최혜진, “Arirang wiseong 아리랑위성 (KOMPSAT),” *Satellite Communications and Space Industry* 위성통신과 우주산업 13:1 (2006), 54-58; MOST, *Gwahakgisulyeon'gam 2005 과학기술연감 2005* (The Yearbook of Science and Technology 2005) (MOST, 2005), 119.

space policy: space technology is a survival technology for the future; space development was needed to secure space area; technology would produce positive effects for expanding Korea's limited territory. Although the growth of the space industry and its spin-offs to other sectors was considered, the major justifications for continuing space development remained survival in the future and the general advancement of science and technology.³⁶ Although the government articulated the 1995 Long-term Plan for Korea's Space Development, that plan still reflected the opinions and plans of researchers.³⁷

The relationship between KARI and SaTReC had rapidly changed as President Kim Young-sam was inaugurated and Dr. Kim Si-Jung became the Minister of MOST. The Korean Government wanted one institute to operate all satellite programs in Korea to make the satellite development program government-led research. The KOMPSAT-1 project started as a government-led project in October 1993. MOST, MCIE, and MPT participated in the project, and the government hoped that KARI would become a leading agency of the KOMPSAT project.³⁸ The research areas of KARI and SaTReC started to overlap. It was the beginning of the struggle.

The first sign of the conflict between KARI and SaTReC emerged in 1993. During the 1993 Daejeon Expo, SaTReC negotiated with the Chinese Research Institute of Space Technology to develop a joint satellite. The two organizations made an official contract, but it was canceled later because the Korean Government agreed with the Chinese government and decided the representative for such an international satellite project should be KARI.³⁹ After the cancellation, MOST pressured to dissolve SaTReC, and Dr. Choi was firmly in opposition. It was the one action to make all satellite development programs a government-led program and make one institute, in that case, KARI, the lead institute of the Korean satellite development program.

This conflict continued to October 1993 during the Parliamentary inspection of the administration of national research institutes of Daedeok Science Town under MOST. In the inspection, KAIST was pressured to cooperate more actively with KARI on satellite development and even close down SaTReC. The KAIST president, Dr. Chun Soung-Soon defended SaTReC, remarking that SaTReC's satellite development project differed from KARI's KOMPSAT project. He maintained that SaTReC developed an experimental technology satellite to advance original technologies and train satellite research experts. As such, SaTReC's research should proceed

³⁶ KARI, *Wujugaebal Jungjanggi Gibongaehwoik* 우주개발중장기 기본계획 (Long-term Planning for Korea's Space Development) (MOST, 1995).

³⁷ Preparatory research for the Long-term Plan for Korea's Space Development was performed by KARI, and the advising committee also consisted of various researchers related to the space field including SaTReC's professors and researchers from either national or private research institutes.

³⁸ Tae Euiyung (2015), *op. cit.*, 109.

³⁹ Choi Soon Dal (2005), *op. cit.*, 222-225; KARI (2001), *op. cit.*, 81; "Past Presidents of KAIST," KAIST, <https://kaist.ac.kr/leaderkr/html/kaist/0105.html> (accessed on July 8, 2021).

as a separate project from those projects related to the development of commercial satellites. He argued the dissolution of SaTReC was unjustified. Due to the still powerful influence of Dr. Choi, KAIST was able to resist the attempt to shut down SaTReC. With the KAIST President's support and Dr. Choi's efforts and leverage, SaTReC overcame this first dissolution pressure. Yet, the launch of its KITSAT-3 project was delayed because KARI and the government insisted that the project only duplicated the KOMPSAT project by KARI.⁴⁰

Yet SaTReC viewed its own roles as quite different from those of KARI. SaTReC conceived its relationship with KARI similar to ISAS and the National Space Development Agency of Japan (NASDA). Therefore, they hoped to maintain a state of coexistence with KARI.⁴¹ However, the government wanted all satellite projects to be government-led. The satellite technology and experts in SaTReC were needed to operate the government-led satellite project in KARI. It became the reason to ask for the shutdown of SaTReC.⁴²

The new Minister of Science and Technology Jung Geunmo, who took office in December 1994 as a successor to Kim Si-Jung, changed the situation. Minister Jung held a more favorable attitude toward SaTReC. He ordered a reexamination of the KITSAT-3 project, and the funding from MOST was resumed. With this new support, SaTReC could restart the KITSAT-3 project and launched the satellite successfully in May 1999.⁴³ Also, SaTReC constructed a new research building in KAIST supported by Hyundai Electronics and opened a branch in London as part of the ERC project.⁴⁴ Based on this expansion, SaTReC also expanded its research area and developed more advanced technologies. KITSAT-1 and KITSAT-2 were experimental satellites using catch-up technology; however, KITSAT-3 applied the most advanced technology. In particular, the camera of KITSAT-3 was the highest level among all small satellites. The rapid development of SaTReC's technology possibly posed a threat to KARI, which perceived SaTReC as having taken away the initiative in satellite development from KARI. In addition, SaTReC undertook the planning

⁴⁰ Choi Soon Dal (2005), *op. cit.*, 225; Ryoo Jang Soo 류장수, *Han'guk Wiseonggaebal* 한국 위성개발 (Korean Satellite Development) (KARI, 1999); Anonymous (KARI Senior researcher), interview by author (April 18, 2011).

⁴¹ Choi Soon Dal, interview by author, 2011. ISAS was founded at the University of Tokyo in 1955 and performed independent research including the Japanese first satellite OHSUMI and rockets as a university research center. NASDA was a Japanese national space agency founded in 1969 under the National Space Development Agency Law.

⁴² KARI (2010), *op. cit.*, 139.

⁴³ Because the KITSAT-3 project was delayed, KITSAT-3 became the first satellite developed under the Long-term Planning for Korea's Space Development; Anonymous (KARI Senior researcher), Interview by author (April 18, 2011); Choi Soon Dal, Interview by author, 2010.

⁴⁴ Sung Chelhwan 성철환, "Ingongwiseong Yeongudong Gigong Gwagiwon nanyeon 8wol jung-gongyeojeong 인공위성 연구동 기공 과기원 내년 8월 준공예정 (KAIST Satellite research building will be constructed in next August)," *Maeil Gyungje* 매일경제 (1995. 12. 30.).

research of KOMPSAT-2, Multi-Purpose Satellite-2 and participated in the important parts of the KOMPSAT-2 project. The government still wanted that one institute led all Koran satellite development programs. The candidate for it was not only KARI but also SaTReC. So, these events heightened KARI's sense of crisis.⁴⁵

Although SaTReC in the early stages only focused on developing KITSAT series satellites, stabilization of its organization and the delay of the KITSAT-3 project led to an enlargement of SaTReC's research areas. Table 1 illustrates the changes in the composition of SaTReC's research projects. In the early 1990s, SaTReC mainly handled its own projects and gave specific sub-projects to other external research teams or organizations. After the first commission project in 1994, SaTReC conducted various sub-projects commissioned from other research institutes. With these research projects, SaTReC extended its research into other areas and took on multiple technologies. This expansion of SaTReC's research abilities threatened KARI, which aspired to be the major national research institute in Korean space development.⁴⁶

Table 1. Composition of SaTReC's Research Projects (1990-1999)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Commissioned projects from funding agencies	6	9	3	3	3	8	9	5	10	5
Contracted out projects	1	7	2	2	4	4	0	0	3	3
Commissioned projects from other research institutes	0	0	0	0	1	1	5	2	2	1

Note. These statistics are based on reports retrieved from SaTReC's archive.

This expansion of SaTReC came as a threat to KARI. In 1994 and 1995, the Korean Government tried to merge or abolished national research institutes. Minister Jung asked each national research institute to submit a reform bill. Many researchers felt their status unstable and left the institutes. Six researchers in KARI also left the institute in just the first two months of 1995.⁴⁷ Although KOREASAT-1, the first

⁴⁵ SaTReC, *Damokjeoksilyongwiseong 2ho Gaebal Yeongugihwoiksaeb* 다목적실용위성 2호 개발 연구기획 사업 (Feasibility Study for the KOMPASAT-2 Satellite Development) (MOST, 1998).

⁴⁶ SaTReC, *Damokjeoksilyongwiseong 2ho Gwahaktabjaeche Gaebalyeongu (I-IV)* 다목적 실용위성 과학탑재체 개발연구 (I-IV) (Development of Scientific Payload of KOMPSAT (I-IV)) (KARI, MCIE, and MOST, 1996-1999).

⁴⁷ Kim Hakjin 김학진, “Gyeonjanglyeok gukjuhwasidaee saneungil(27) Jeongbuchulyeon yeonguwondeuli ddeonanda 경쟁력 국제화시대에 사는길 (27) 정부출연연 연구원들이 떠난다

Korean broadcasting, and communication satellite, was launched in 1995, it was not KARI's product. The lead organization for the project was Korean Telecom (KT), and it was Lockheed Martin Astro Space who made the satellite.⁴⁸ KARI started its own satellite project in 1994 but had not been successful with it yet in 1996. This situation supported the argument that the satellite development program aspect of KARI should be moved to SaTReC.⁴⁹

However, upon the inauguration of Minister Seo Jung Wook in 1999, the situation changed entirely, precipitating the appearance of shutdown pressure for SaTReC.⁵⁰ MOST insisted that SaTReC's primary role should be training satellite research experts and claimed that SaTReC focused only on the development of satellites and paid no attention to training experts. MOST finally proposed merging the two organizations, arguing that the merger would reduce the budget and avoid overlapping investment. With this argument, MOST and KARI then pressed SaTReC to reduce the scope of its research.⁵¹ Such proposals caused strong resistance from SaTReC's members and led to a strike that lasted one month. As the last suggestion, SaTReC's members suggested to KARI that all members of SaTReC would move to KARI as one team and keep its research autonomy. KARI rejected the offer. SaTReC members tried to find a way to keep SaTReC as an affiliated research center of KAIST as the ERC project expiration impended.⁵² However, SaTReC finally got the inadequate evaluation of ERC final evaluation. SaTReC's early members decided to create their own company, SaTReC-I, and continue their satellite work. Almost all of the early members of the organization left SaTReC. And it was finally reduced to one of the small university research institutes in late 1999, although SaTReC was not merged to KARI.

The second period does show some interesting features. Science, especially big science that requires long-term effort and a large amount of support, needs to maintain an appropriate distance from politics. Too much proximity to politics makes science vulnerable to changes in politics, including changes in administration. Yet too far a distance makes it difficult for the organization to receive enough support from the government for successful research. Both will have a problem when trying

(Competitiveness, the way to survive in globalization era (27) the researchers of national research institutes leave the institutes),” *Dong-a Ilbo* 동아일보 (1994. 2. 18.).

⁴⁸ KT Satellite Project Team (1999), *op. cit.*

⁴⁹ Hong Jaehak 홍재학, “The Interview of past president,” in KARI (2010), *op. cit.*, 32-33. This crisis of KARI was dissolved by Minister Yi Sanghee 이상희, who established KARI and empowered to KARI.

⁵⁰ KARI (2001), *op. cit.*, 80-87; Choi Soon Dal, interview by author, (April 8, 2011).

⁵¹ Ryoo Jang Soo (1999), *op. cit.*

⁵² SaTReC, *In'gongwiseongyeongusenteo Hyeonhwang mit Gaepyeon Geoneuian* 인공위성연구센터 현황 및 개편 건의안 (The Current Condition and Suggestion of Reorganization of SaTReC) (SaTReC, 1998).

to maintain consistent research.⁵³ SaTReC's case in the second period illustrates the problem of having too close a proximity to politics. As the Korean Government started to change the Korean satellite development to "government-led," the government wanted one institute to lead all of the Korean satellite programs. SaTReC and KARI should make an effort to be that institute because it was the way to survive. As a result, Korean satellite development policy experienced ups and downs from governmental changes, such as the ministerial changes at MOST. Some of those changes are now estimated to have caused a delay in Korean small satellite development for more than five years by satellite experts.⁵⁴

The politics which influence science are the change of Minister of MOST in this case. The influence of the change of Minister was common. The left of Dr. Jung Geunmo from KAIS to Cornell University resulted from the change of Minister. The establishment of ISSA resulted from the change of Minister of MOST from Minister Lee Jeong Oh to Minister Kim Sung-jin.⁵⁵

The influence of the change of Minister of MOST was due to the difference of careers of two ministers, Jung Geunmo and Seo Jung Wook. Minister Jung had a deep interest in the improvement of university research. Even when he went to the U.S. to study abroad, his goal was to learn how to nurture talented people and make good universities and research institutes after finishing his studies abroad.

His strong support of universities continued with the establishment of KAIST. When he was a professor at the Polytechnic Institute of New York, Minister Jung met Dr. John A. Hannah, the head of the United States Agency for International Development (USAID). Minister Jung had a close relationship with him as a mentee and asked to establish a science & technology specialized graduate school in Korea for the national development of Korea. It was the starting point of KAIST. After that, Minister Jung performed an essential role in establishing KAIS (Korea Advanced Institute of Science). He participated in the Terman investigation team and played a leading role in writing the Terman report. After KAIS was established, he became the first vice president of KAIS. After he left KAIST, he still has a strong affection for KAIST, and he even said that "KAIST is the reward of my life."⁵⁶

⁵³ Jung Byung Kul 정병걸, Seong Jieun 성지은, "Gwahakgisulgwa Sangjingjeongchi: Chamyoe-jeongbueui gwahakgisul jeongchaekul jungsimelo 과학기술과 상징정치: 참여정부의 과학기술 정책을 중심으로 (Science and Technology as Symbols: The Case of Science & Technology Policy in Roh Moo Hyun Government), *The Journal of Korean Association for Policy Sciences 한국정책과학학회보* 9:1 (2005), 28-33.

⁵⁴ Park Sung Dong 박성동, "KBS Sisa 10dae Wujugangguk Daehanminguo, Bulpeyonhan Jinsil KBS 시사 10대 우주강국 대한민국, 불편한 진실 (KBS Current Affairs KBS 10 Space Power: Republic of Korea, An Inconvenient Truth)," KBS (2011. 4. 12.).

⁵⁵ The committee of KASI's 40 years history (2014), *op. cit.*, 86.

⁵⁶ Jung Geunmo 정근모, *Gijeokeul Mandeun Nalaeui Gwahakja* 기록을 만든 나라의 과학자 (The Scientist in the country which made miracle) (Seoul: Korea.com, 2021), 33-43, 116-169.

The SRC-ERC program was also an important project to Minister Jung. When he was the director of KOSEF, he made the SRC-ERC program. He prepared the program before becoming the director with Dr. Choi, the director of KOSEF at that time, and suggested the model of SRC-ERC himself. The goal of the program was to strengthen the university research capabilities. The SRC-ERC program was a perfect fit for nurturing talented people and making good universities and research institutes. After Minister Jung became the director of KOSEF, he showed strong affection for the SRC-ERC program. He secured the budget for the program as he visited Deputy Prime Minister Cho Sun. After becoming the Minister of MOST under President Roh Tae-woo's administration, he made the stable settle-down of the SRC-ERC program a top priority.⁵⁷

SaTReC was an ERC center in KAIST. And the president of SaTReC was Dr. Choi Soondal, who worked with Minister Jung in KOSEF. Even Dr. Choi and Minister Jung were in-laws. So, it was natural that Minister Jung wanted to support SaTReC.⁵⁸

On the other hand, Minister Seo is a person who has built up his career based on national research institutes. As he served as the president of ADD and KIST and participated in the KOREASAT project as a president of Korea Mobile Communication in the early stage of the Korean space program, he firmly believed in the power of government-led research. Also, Minister Seo thought that universities lacked an understanding of the nature of modern science and the ability to manage research projects. So, he argued that the government should lead the coordination, control, and synthesis of R&D projects. These gaps between the two ministers' beliefs and wills influenced the struggle between SaTReC and KARI in making a government-led satellite development program in Korea.⁵⁹

SaTReC's influence on the Korean satellite development program decreased during this process, and its role changed accordingly. It no longer performed diverse roles as it had done earlier and relegated some of those roles to other institutions. The government also now expressed its full commitment to the long-term planning of the Korean space program. Although the government plans included researchers' opinions in their early versions, they only reflected the view that the roadmap of the Korean space program should be drawn by the government, not by any private institute.⁶⁰

SaTReC also gave up its management role. SaTReC was the lead organization in

⁵⁷ *Ibid.*, 239-241, 247-250; "KAIST History," KAIST Archives Service, <https://archives.kaist.ac.kr/eng/history.do#> (accessed on July 23, 2021).

⁵⁸ Jung Geunmo (2021), *op. cit.*, 234-238

⁵⁹ Seo Jung Wook 서정욱, "Gwahakeui 'toyang'eung daejak 과학의 '토양'은 대학 (The Basis of Science is universities)," *Kyunghyang sinmun* 경향신문 (1995. 4. 9.).

⁶⁰ KARI (1995), *op. cit.*

the first period and managed satellite projects because there were no other research institutes available to manage and implement satellite development projects. In contrast, the KOREASAT series (1, 2, 3) and KOMPSAT-1 were developed in the second period and were managed by KARI and KT.⁶¹ SaTReC still managed the KITSAT-3 project as a lead organization, while it also participated in other projects, including the KOMPSAT projects.⁶² But various functions and roles in space development initially concentrated in SaTReC were now dispersed to various institutes.

The second period also demonstrates the start of a government-led system. The Korean Government had clear policy goals for the Korean space program based on long-term planning; for example, it argued that space development should occur under the government's control. Also, it emphasized that Korea was at the beginning stage of space development and that Korea had to start space development with government leadership and only later invite participation by the private sector. For the KOMPSAT project, the government claimed that the first stage (1994-1998) should be government-led.⁶³ It also tried to strengthen the government-led system by making KARI a representative research institute.⁶⁴

Opening the Korean Satellite to Industry (2000-2005)

The third period of SaTReC's history started with different conditions in place than the previous periods. Now, economic benefits became the chief rationale for the Korean space program. The 2000 KARI report indicated that space was a new challenge area with great potential for commercial space technologies. Commercial benefits thus emerged as the important criteria for the Korean space program.⁶⁵ In addition, the 2004 report mentions the importance of quality of life, thus further defining the vision for the Korean space program in order "to find the way to increase national security and the quality of nation's life, ultimately, by a new vision of space development."⁶⁶ The 1997 Korean financial crisis accelerated the tendency to emphasize the economic benefits of the space program. The crisis widened the gap between rich

⁶¹ KARI, *Damokjeok Silyongwiseong Chonggwak Saeob Gwanli (I-V)* 다목적 실용위성 총괄 사업 관리 (I-V) (Comprehensive Project Management of KOMPSAT (I-V)) (MOST, MCIE, and MIC, 1995-2000); KT Satellite Project Team (1999), *op. cit.*

⁶² SaTReC (1996-1999), *op. cit.*

⁶³ KARI (1995), *op. cit.*, 10-11.

⁶⁴ *Ibid.*, 84-87.

⁶⁵ KARI, *Wujugaebaljungjanggi Gibongyehwoik Sujeongan* 우주개발중장기기본계획 수정안 (Planning for Update of Long-term Plan for Korea's Space Development) (MOST, 2000).

⁶⁶ Korea Aerospace University, *Wujugaebal Jungjanggi Gyehwoik Sujeongeul Wihan Gihwoikyeongu* 우주개발 중장기 계획 수정을 위한 기획연구 (Feasibility Study for Update of Korean Mid- and Long-term Space Development Plan) (MOST, 2004), 87.

and poor, and the middle class almost collapsed. The general public became increasingly aware of the economic costs and also the benefits of any government policy. More and more economic benefits, such as the quality of life, were emphasized as the rationale for future space policy. In particular, President Roh Moo-hyun's administration, inaugurated in 2003, emphasized science and technology as the bedrock of the president's policy.⁶⁷ These changes also influenced the space program.

After the early members of SaTReC left in late 1999 and early 2000, KARI became a representative space research institute in fact as well as in name, claiming that KARI would grow to be a national specialized space development research institute. With KARI as the central figure, various actors in space development research, including ADD and ETRI, strengthened their cooperation with KARI. In this situation, SaTReC's funding line changed. Instead of receiving funding directly from the government ministries, SaTReC obtained funding from KARI, which received all space-related budgets from the government and then distributed it to other research institutions. For example, although Science Technology Satellite-1 (STSAT-1) started as SaTReC's own project in 1998, it later became a KARI project.⁶⁸ During this process, the satellites were renamed from KITSAT-4 to KAISTSAT-4 and to STSAT-1. SaTReC did actual development work for STSAT-1, while the head organization was KARI, and the funding came from KARI. Since SaTReC received its budget from KARI, a national research institute, SaTReC's research was affected by governmental demands, and the research autonomy of SaTReC became limited.⁶⁹

In 2000, its own research projects were only their operations of KITSAT-1, 2, 3; the ground station management for remote sensing satellite image receiving and processing; and basic research including satellite engineering, microsatellite, and basic technology development such as synthetic-aperture radar. Other projects were essentially sub-projects of the KOMPSAT development project. The years following 2000 showed similar characteristics of research project composition. SaTReC no longer gave sub-projects to other research laboratories but instead received sub-projects from research institutes, including KARI, the National Weather Service, and the National Security Research Institute. The other signs of change in SaTReC are evidenced in the characteristics of SaTReC's actual research. In the early stage, SaTReC developed satellites and undertook various research projects not directly related to end products. SaTReC could not pursue research unrelated to end products in the third period, as its independent research was not guaranteed anymore.

However, this change also meant the beginning of the satellite industry in Korea.

⁶⁷ MOST, *The Yearbook of Science and Technology 2004* (MOST, 2004), 55-65, 75-77.

⁶⁸ MOST, *The Yearbook of Science and Technology 2001* (MOST, 2001), 20.

⁶⁹ Cho Hwang Hee 조황희, *Gukgawujugaebaleui Hyoyuljeokin Chujinchegeye Gwanhanyeongu* 국가우주개발의 효율적인 추진체계에 관한 연구 (Study on the Efficient Implementation Mechanism for Korea's Space Development (MOST, 2006), 10.

The 20 members of SaTReC who left SaTReC in 1999 and 2000, including Dr. Choi Soondal, established a venture company, SaTReC Initiative (usually called SaTReC-I). From its inception, SaTReC-I had a vision to lead the satellite industry.⁷⁰ The establishment of SaTReC-I triggered the Korean satellite development program to expand its boundary to society, especially to industry.⁷¹

The members of SaTReC-I said what they do, making satellites, has not been changed, but the format of the organization changed from a university research center into companies. The goal of SaTReC-I was not to earn money but to keep developing satellites with their free will. However, the change of format provided enormous freedom to SaTReC-I. As SaTReC-I become a private company, SaTReC-I could expand its research area freely only if it could run its business profitably. Based on this, SaTReC-I expanded its business fields into various fields. In addition to the satellite-related business such as satellite technology consulting, satellite system development and exporting, satellite parts, satellite imaging, SaTReC-I commercialized a monitor capable of early detection of radiation dose. It is similar to what SaTReC did in the past, which researched in satellite technology for society in general. Also, SaTReC could expand its research not only more comprehensively but also more profound than before. The advanced technology of SaTReC-I was not anymore the point that caused the conflict with KARI. The resolution of the satellite image in RazakSat was 2.5 cubic meters, but the SaTReC has advanced the technology to 0.3 cubic meters. It is the most advanced satellite image technology.⁷² SaTReC-I also expanded its satellite lineup from under 100kg to 500kg.

SaTReC-I also could do international cooperation freely. In 2001, the year after its establishment, SaTReC-I signed a contract with Nanyang Technological University Singapore (NTU) and began consulting on the test satellite X-Sat. It also carried out various technology consulting projects in more than ten countries. In 2005, by exporting Razaksat-1 to Malaysia, it exported Korea's first overseas export satellite. The international cooperation of SaTReC-I actively continued, with that more than 70% of the total sales of SaTReC-I being overseas sales. Considering that satellite development cooperation with China was canceled in 1993, it was a huge change.

Now, SaTReC-I is established as a major space company in Korea. And since its establishment, SaTReC-I is the only company that could process all satellite development steps from planning to manufacturing in Korea. SaTReC-I went public on

⁷⁰ SaTReC-I is a successor of SaTReC by calling SaTReC-I a protagonist of KITSAT series. So, the history of SaTReC-I could be considered as a part of SaTReC.

⁷¹ Tae Euikyung (2015), *op. cit.*, 116.

⁷² Leem Jungsu 임정수, "In'gongwiseong gaebalsa SaTReC-I, gisulgaseongbi wontop... sujuyumang 인공위성 개발사 썬트레이이, 기술가성비 원톱... 수주유망 (SaTReC-I, satellite development company is top of cost performance ratio... hopeful result of orders)," *Asiagyungje* 아시아경제 (2021. 2. 28.).

KOSDAQ in 2008. Two subsidiaries of SaTReC-I, SI Imaging Services (SIIS) and SI Analytics (SIA), are also expected to go public.⁷³ Through this, SaTReC-I successfully settled as an industry and established the space industry by expanding related fields.

After the establishment of SaTReC-I, the satellite industry in Korea has continuously expanded. Based on satellite communication and broadcasting, the satellite industries increased. In the 2005 survey of the space industry, only 16 companies had researchers in all satellite-related fields, including ground station, payload, satellite system, etc. Also, most companies performed the sub-project of the big satellite projects in which KARI operated and did not have their own satellite projects. The most sales of satellite industry were from SaTReC-I until 2006.⁷⁴

The survey of the space industry in 2010 defined space industry as "the industry for space development and the products and services created through space development."⁷⁵ It was the first trial to define the space industry, including the satellite industry in Korea. And it also means that the space industry, including the satellite industry, has been accepted as a part of the industry in Korea.

In the third period, the Korean satellite development program changed to a government-led program. The roadmap already set the research plan for Korean space development and the mid-term and long-term plan for Korean space development. In addition, the government enacted its Space Development Promotion Act in 2005. Following the Act's enactment, the government created a new administrative entity for space development and the National Committee of Space Development in 2006. With these actions, the government consolidated Korean space development as government work. Space development management became KARI's responsibility.⁷⁶ KARI has been the head organization for these projects, and other organizations have participated in the projects.⁷⁷ Also, KARI emerged as the representative of space program public communication and worked to promote space programs with the Ministry of Education and Science and Technology (MEST).⁷⁸ The struggle between KARI and SaTReC caused the founding members of SaTReC to leave and create the

⁷³ SIIS is the marketing and sales representative of KOMPSAT series and SIA has expertise in image analysis based on artificial intelligence and deep learning.

⁷⁴ KARI, *2005 Wujusaneob Siltaejosa* 2005 우주산업 실태조사 (Survey of Space Industry 2005) (MOST, 2005); Choi Nammi 최남미, Sung Joonyong 성준용, "2007nyeon Han'gukeui wujusaneob siltae 2007년 한국의 우주산업 실태 (Actual Condition of 2007 Korean space industry)," *Hang'gongwujusaneobgisuldonghyang* 항공우주산업기술동향 5:2 (2007), 3-10.

⁷⁵ KARI, *2010 Wujusaneob siltaejosa* 2010 우주산업 실태조사 (Survey of Space Industry 2010) (MOST, 2010), 17-18.

⁷⁶ Cho Hwang Hee (2006), *op. cit.*, 17.

⁷⁷ KARI (2000), *op. cit.*, 22; Korea Aerospace University (2004), *op. cit.*, 141-146.

⁷⁸ During the third period, MOST was merged with Ministry of Education. So, the name of the ministry changed to the Ministry of Education and Science and Technology in 2008.

government-led space program in Korea. But the Korean space program outside the government-funded program expanded its boundary to the industry.

Opening the Korean satellite to other countries and the public (2006-2013)

The 2006 White Paper of Space Development presents various rationales, including space industry global competitiveness, enhancement of the nation's quality of life by space application and procurement of space areas, and the heightened national pride through the successful space program.⁷⁹ On this basis, the technology transfer in the space field is another way to heightened national pride because it shows that Korea became an advanced country that could provide its advanced technologies to late-comer countries.

In this period, the Korean satellite development program expanded its boundaries to other countries and the public. As mentioned above, SaTReC-I made an advisory contract with NTU in 2001. Seven SaTReC-I researchers stayed at NTU, providing short-term training programs to faculty on satellite engineering, and performing the role of technology consultant in various fields after launching the satellite.⁸⁰ In addition, SaTReC-I similarly operated the Razaksat project of Malaysia. Since 2001, 20 Malaysian researchers have learned and developed satellites together in SaTReC-I.⁸¹

However, the main focus was satellite consultations with various countries. The full-fledged opening of the Korean satellite development program started in 2006 with the United Arab Emirates (UAE). When the UAE began its space program in 2006, the UAE used SaTReC-I's case as a role model of satellite technology independence and requested cooperation with SaTReC-I. Technology transfer to the UAE proceeded in a similar way to SaTReC's study-abroad in the University of Surrey. DubaiSat-1, launched in July 2009, was manufactured by SaTReC-I, and after that, the design and manufacturing proportions of UAE members increased through DubaiSat-2 and -3 productions. In addition, SaTReC-I cooperated with KAIST and opened the master's degree program for UAE members. This degree is for UAE members to receive an academic education and acquire satellite technology through actual satellite development.

⁷⁹ MOST (2006), *op. cit.*

⁸⁰ Kim Wanmuk 김완목, "SaTReC-I, bencheogieob Singapore Wisunggaebal chamyeo 세트렉아이, 벤처기업 싱가포르 위성개발 참여 (SaTReC-I, a venture company, participated in Singaporean satellite development)," *Maeilgyungje* 매일경제 (2001. 4. 10.).

⁸¹ Lee Eunpa 이은파, "Mahathir chongli, daedeokvalley bangmun 마하티르 총리, 대덕밸리 방문 (Prime Minister Mahathir Mohamad, visit Daedeok valley)," *Yeonhap News* 연합뉴스 (2002. 5. 24.).

In most cases, students obtained a master's degree from the Department of Aerospace Engineering during the last two years of their stay in Korea. However, Omran Sharaf completed a master's program at the Graduate school of Science and Technology Policy at KAIST. SaTReC-I supported their tuition and continued to instill responsibility and enthusiasm as a space development leader in a latecomer country through regular leadership training. At that time, UAE members nurtured the dream of space and working culture through their experience in Korea. Mohammed Al Marmi, the Minister of Mohammed bin Rashid Space Center (MBRSC), said, "at that time, I was able to learn how to work efficiently and how to take care of the details in each subsystem." It can be said that the role of SaTReC-I was not just a technology transition but the UAE's mentor in the space program. Most UAE members in SaTReC have leading positions in the UAE space program now.⁸²

Since 2010, KARI has also participated in opening Korean satellite technology to other countries. KARI has organized International Space Training Program (KARIST) since 2010. For two weeks, young professionals from developing countries visit Korea and train as space experts. The training covers space engineering to space science, as well as policy and law. However, because Korea is still at a catch-up level in the space launch vehicle, many parts of training are satellite-related topics, including satellite systems engineering, fundamental satellite control, and Satellite Assembly, Integrating & Testing. Until 2019, 245 persons from 34 countries have participated in this program.⁸³

The Korean satellite development program was opened to the Korean public later than to other countries. The success of KITSAT-1 and KITSAT-2 in 1992 and 1993 brought further public attention to SaTReC. When KITSAT-1 was launched successfully in 1992, President Roh Tae-woo highly praised SaTReC, saying that SaTReC had helped open a new era of space exploration and demonstrated the level of Korean science and technology in the world.⁸⁴ Also, the media depicted KITSAT-1 as an important event and reported on it at length. During the 1993 Daejeon Expo,

⁸² Omran Sharif: Project Manager of the Emirates Mars Mission, Sarah Al Amiri: the Minister of State for Advanced Technology, Amer al Sayegh: Deputy Director of Space Program, Mohammed Al Marmi: the minister of Mohammed bin Rashid Space Center (MBRSC); Kim Inhan 김인한 "Hwaseongtamsa" UAEae wujugaecheok ggum simeojun SaTReC-I '화성탐사' UAE에 우주개척 꿈 심어준 세트렉아이 ('SaTReC-I, which built the dream of 'Mars Exploration' to UAE)," *HelloDD* (2021. 1. 31.); Kim Inhan 김인한, "UAE tamsaseon 'heumang' hwaseonggwedo jinip, jeonsegye 5beonjjae UAE 탐사선 '희망: 화성 궤도 진입, 전세계 5번째 (UAE spacecraft 'Hope' entered Mars Orbit. The world fifth)," *Hello DD* (2021. 2. 10.).

⁸³ KARI, "KARIST," kari.re.kr/eng/sub06_04.do (accessed on July 28, 2021); KARI, "Statistics of KARIST 2012-2013" (unpublished material).

⁸⁴ Roh Tae-woo 노태우, "Cheot gwahakwiseong 'wooribyl-lho' balsa seonggonge buchineun chuckha meseji 첫 과학위성 '우리별 1호' 발사 성공에 부치는 축하 메시지 (The congratulatory Message for the successful Launch of KITSAT-1, the first scientific satellite)," National Archive, <https://www.pa.go.kr/research/contents/speech/index.jsp> (accessed on July 25, 2021).

the model of KITSAT-1 was exhibited, and a ground station was set up and operated as a demonstration. In addition, KITSAT-2 was launched during the 1993 Daejeon Expo, attracting further public attention. The exhibition of space exploration artifacts at the 1993 Daejeon Expo, such as the mock-up of KITSAT-1 and 2, was most popular in the 1993 Daejeon Expo.⁸⁵ However, despite this tremendous public interest, the satellite development program remained a novelty, still relatively isolated from society.

After the Korean Government designated KARI as the representative research institution for the Korean space program, KARI appeared to be at the forefront of the public eye. SaTREc still had its online message boards listed on its webpage, allowing communication with the public; however, the message boards disappeared in 2003. The KARI promotion team and MEST took on the role of promoting the Korean space program.⁸⁶ Especially, the Korean Government promoted the space program for the popularization of science.⁸⁷ The Korean Government settled on the Space Development Promotion Act and announced the year of 2005 as the new beginning of the space program. The government also started the space culture movement with the slogan "Space Korea." It held various events, including World Space Week, loading a human chip in a KOMPSAT, and selecting an honorary ambassador for space development on the Internet.⁸⁸ When KOMPSAT-2 launched, many articles about KOMPSAT-2 were published years before the launch, and the satellite was continuously exposed to public scrutiny.⁸⁹ However, the public still did not talk about Korean satellites in daily life for the satellites were just one national achievement, and they forgot about the satellites rapidly. Public did not raise other opinions about the Korean satellite development program. The development of satellites and launch vehicles followed the mid-term and long-term plan for Korean space.

The exposure of the space program to the public accelerated after 2008 with a landmark event: Korean Astronaut Program (KAP). The selection process began in April 2006 and attracted significant public attention. A total of 36,206 persons applied to the program, and two candidates, Dr. Ko San Ko, and Dr. Yi Soyeon, were selected. Starting with the beginning of the program to determine the final candidates and Dr. Yi's space trip, the whole process was broadcast by SBS in its program titled

⁸⁵ Yoon heeil 윤희일, "Woojutamheomgwan technopiagwan cheonsonyundeulen ggumeui jangso, 우주탐험관 테크노피아관 청소년들에겐 '꿈의 장소' (The exhibition of space exploration and the exhibition of technopia were the dream place for teenagers)," *Kyunghyang sinmun* 경향신문 (1993. 9. 8.).

⁸⁶ KARI, *Wujugaebal Hongbojeonlyak yeongu* 우주개발 홍보전략 연구 (Research on Public Communication Strategies for the National Space Development) (KARI, 2002).

⁸⁷ *Ibid.*, 12-13.

⁸⁸ MOST, *Yearbook of Science and Technology 2005* (Gwacheon: MOST, 2005), 117-118.

⁸⁹ KARI, *Wuju Sokeui Daehanminguk, Arirangwiseong 2ho Baekseo* 우주 속의 대한민국, 아리랑위성 2호 백서 (Korea in Universe, White Paper of KOMPSAT-2) (MEST, 2009).

2008 Space Korea.⁹⁰ KSLV-1 was the most spotlighted project of the whole Korean space program. A great number of people watched the launch of KSLV-1 and lamented the failure of the KSLV-1 launch. With the two failures of KSLV-1, two STSAT-2 satellites were destroyed. SaTReC had to prepare another satellite for the third trial of the KSLV-1 launch, and finally, STSAT-2C was rapidly developed and launched with KSLV-1 in 2013.

The increase of public exposure had happened in the past, but this time the meaning was different. In the past, the public did not share the opinion about the Korean space development program and remained as a receiver of given news. However, this time, the public raised their opinion about the program and their opinions made a change in the plan of Korean space program. The public was not a passive receiver anymore but an active actor of the Korean space program. The controversy over whether Dr. Yi Soyeon was an astronaut or a space traveler had continued over ten years. The public debated the meaning of the Korean Astronaut program.⁹¹ Also, although the launch of KSLV-1 was successful, there were many negative opinions. Some said that it was not the success of Korea since the first stage rocket was imported from Russia. And STSAT-2 was also criticized due to its lower performance than the initially planned STSAT-2. The opinion did not remain as an opinion. This negative opinion of the Korean public accelerated the development of KSLV-2, and opposing views on the Korean Astronaut Program still disturb the next human space program. In this period, greater public exposure to space programs has led the general public to monitor and evaluate space programs. Now, the public has emerged as one of the most important external forces.

In this fourth period, the Korean satellite development program expanded its boundary to other countries and the public. Before this period, Korea had learned from other countries' satellite development programs in various ways during the satellite projects. KITSAT was from the technology of the University of Surrey, KoreaSAT was from the LMAS, and KOMPSAT was from the TRW. However, in this fourth period, other countries learned from the Korean satellite development program. And although the public interest was not always good, the space program's public interest, including the Korean satellite development program, strongly increased in the fourth period, and the public interest changed the role of the public. The space program is not far removed from the public anymore. Throughout all these events, the Korean space program has moved beyond the scientists' domain, and as

⁹⁰ MOST (2006), *op. cit.*, 111.

⁹¹ An Hyoun-Joon 안형준, "Yi Soyeoneun Wujuininga gwangwangfaekinga? - ANT Gwan-jeomeseobon Han'gukchoichowujuin Nonjaeng 이소연은 우주인인가 관광객인가? - ANT관점으로 본 한국최초우주인 논쟁 (Is Yi Soyeon an Astronaut or a Space Tourist?: The First Korean Astronaut Debate on the View of ANT)," *Journal of Science & Technology Studies 과학기술학연구* 9:1 (2009), 89-127.

a part of daily life, the public started to participate in the decision of the Korean space program.

The Korean satellite technology that started from SaTReC expanded its boundary to Government and other research institutes, KARI, industry, other countries, and the public. The effort of the Korean government and changes in space development and its policy also worked to reduce SaTReC's role, leading it to expand the Korean satellite development program to other regions in the society, including the public and other countries.

Conclusion

This paper tracks the history of SaTReC, which parallels the trajectory of opening the Korean satellite development program to society. Korean satellite development program and its policy have undergone many changes during the last three decades, and the transition of Korean space policy followed the unique circumstances within each period. SaTReC, initially isolated from society and pursued only the research it wanted to undertake, has gradually been exposed more to society. Its first exposure was to the Korean Government and other research institutions, particularly KARI, industry, other countries, and finally, SaTReC was exposed to the general public.

SaTReC could not continue in its previous form and had to distribute its roles to other organizations. SaTReC lost many of its original characteristics and the early stage's prestige and eventually became just one of several research institutes. The government began taking a more active role in both development and policy. The decision-making process no longer remains within an autonomous scientific community; the Korean Government is now a dominant decision-maker in the satellite development program. An autonomous scientific community could not stay in the position that leads the satellite development program. This process illustrates the unique characteristics of the Korean space program that started with a relatively autonomous research group and evolved into one that is now government and market-led.

The main actors in the Korean satellite development program have also changed. The influence of SaTReC, the only major actor in the Korean satellite development program in the early stage, decreased as time passed. The government and KARI stepped in and became major actors. By reducing SaTReC, the satellite industry appeared as an important actor of the Korean satellite development program and will be a major actor. The general public also emerged as an important stakeholder in the Korean satellite development program. With these changes, the Korean satellite development program, formerly long isolated from the public, has become a part of general society. Table 2 shows the transition of Korean satellite development program.

The tracking of the history of SaTReC and SaTReC-I provides an understanding and insight into the Korean satellite development program. Through the case study, this paper claims that the Korean satellite development program did not follow the typical characteristic of big science, government-led, but started from an autonomous research group and transferred to the government-led program later. Also, this paper shows how the Korean satellite development expanded its boundaries to other societies and found its position in society under environmental change. Now, the environment surrounding the space industry is changing significantly again. The era of new space centered on private companies is opening, and large companies such as Hanwha and Hancom are jumping into the space business. In this condition, where could the Korean satellite development program expand its boundary without limit again? And how should it find its new position in the new era? By analyzing the history of the Korean satellite development program, this paper could provide some clues for the future of the Korean satellite development program.

Table 2. The change in Korean Satellite Development

	The 1 st period (1989-1993)	The 2 nd period (1994-1999)	The 3 rd period (2000-2005)	The 4 th period (2006-2013)
Actors	SaTReC	SaTReC KARI The Government	KARI The Government Industry	KARI The Government Industry Other countries The Public
Degree of Openness	Isolation from society	Competed with KARI Interference from the Government	Government-led Industry started	Government-led & Market-led Technology Transfer to other countries The public joins
Role of SaTReC	Planning satellite development Managing the projects Research Promotion and public communication	Participation in planning Managing the projects Research Operating existing satellites Public communication partly	Research, Operating existing satellites Public communication partly until 2003	Research, Operating existing satellites

Abstract

This study examines how the Korean satellite development program was established in Korean society and expanded its boundaries through tracking the history of KAIST Satellite Technology Research Center (SaTReC) from 1989 to 2013. Based on documentary analysis, I argue that the Korean satellite development program was started by an autonomous research group, SaTReC, and evolved into a government-led program. This process is divided into four periods based on the boundaries of the Korean satellite development program: 1989-1993, 1994-1999, 2000-2005, and 2006-2013. Although the role of SaTReC was reduced in the Korean satellite development program, the Korean satellite development program expanded its boundaries from SaTReC to the Government and Korea Aerospace Research Institute (KARI), to industry, and finally to other countries and the public. New actors of the Korean satellite development program raised according to the expansion of boundaries. This study shows that the Korean satellite program continuously has expanded its boundaries to find its position in society under environmental change and provides insights for the future of the Korean satellite development program in the new era.

Keywords: Korean Satellite Development Program, Expansion of boundaries, Conflict between Institutions, SaTReC, KARI