



Methodology of Research and Development

From Research of Satellite Communications to General Research

③ Method for National Security Related Research

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In this opinion column, it is intended to argue how to conduct research and development (R&D) on satellite communication, especially for national security. This is why we step forward in the 21st century of the chaos which was determined by the terrorist attacks to the U.S.A. on September 11, 2001, and in order to deal in a century of chaos, R&D of national security, especially satellite communications becomes particularly more and more important. On that occasion, an R&D methodology in general R&D as well as one of satellite communications is argued based on experience of the management of Communications Research Laboratory of the author's former job. Therefore, the content may be based on the author's own dogmatism and prejudice, but please forgive me because of an opinion column.

At this series No. 1, under a subtitle: "Competition Predominance and Researchers' Attitude", the topics of competition dominance and innovation, researchers' attitude, and what study should be done are considered. Therefore, at this series No. 2, it is considered how the research management should be done. Then I would like to think about how to proceed studies related to national security on this series No. 3. I would like to treat the topics including a difference from a conventional study for a national security-related study, and the acquisition and handling of information. The U.S. decreases defense expenditures for financial improvement as recent situation, and the allied countries are expected reinforcement of more role. It is thought that importance of a military communications satellite will rise more and more in future for the acquisition of information and its circulation.

◆◆ Overview of Author's Past Opinions about National Security Related Research ◆◆

In this series of column No. 3, I would like to discuss on how to proceed the national security related research while taking satellite communications for an example. For this purpose, the increase of necessity of satellite communications in national security should be described at first, but on this matter I would like to review the author's opinions that has been published so far [1][2][3][4][5]. It was begun in 2004.

■ Opinion in 2004

The references [1] entitled "Can We Understand Wind?" described that we should recognize more the increased role of research and development (R&D) for the national security, in order to protect our country from the world of chaos after entering to the 21st century. It also described that the space development is important from the technology security point of view. I insisted that we should promote the manned space development that we have not developed in our country while the national research institute should at least increase its contribution to national security. In special, the change of role of national institute and Incorporated Administrative Agency (IAA) need to be

recognized. Giving an example of the National Institute of Information and Communications Technology (NICT), the roles were enumerated including Internet security, systematic measures for electromagnetic environment, and technology support for an information gathering satellite. The reflection to the next Basic Plan of Science and Technology (the third plan) would be unavoidable. The reflection to space development plan would also be inevitable.

According to the consideration about the future space development through the discussion with members of JFSC editorial committee, this discussion was performed about the space development for the national security as well as for the manned space development from the recent trend point of view. This argument gave the basics of discussion afterward that the national institute should be specialized in national security related studies.

■Opinion in the End of 2008

In the references [2] entitled "National Security: How We Should Push Forward R&D of Satellite Communications Technology As a Nucleus of Network Centric Defense System", the importance of satellite communications technology and its method of R&D were discussed as a part of national security, based on the big change by the conclusion and its enforcement of the Space Basic Law. We are at a loss how the R&D of satellite communications technology related to the national security is different from the conventional R&D we have performed so far, since we have gotten used to the environment of space development which has been limited to the peaceful (non-military) purpose since it was started in Japan.

Therefore, it was described that a method of R&D related to national security has a performance different from conventional one. The increased importance of satellite communications in the current and future utilization of the U.S. military applications was discussed based on the published papers. Then how to push forward the R&D in our country in future was considered in an example of NICT. Furthermore, it is necessary that information of national security is acquired for the social safety, and is transmitted to the necessary place quickly, due to September 11 attack and war and terrorism occurred after that. In this meaning it was mentioned that information and communication, in particular, satellite communications is the nucleus technology.

Here, the network centric structure was investigated concretely and discussed by having known the power of satellite communications and its network according to an article of Aerospace America [6].

■Presentation at Study Group Meeting of IEICE in the Beginning of 2009

A paper [3] entitled "Satellite Communication for National Security: Increase of Role and a Method of Future Research" including national security issue was presented at the IEICE joint meeting of Satellite Communication Study Group and Space and Navigational Electronics Study Group. This presentation was based on the discussion that had been done so far, but it might have been a little exciting presentation in such a meeting. For the contents, the importance of satellite communications technology as a part of national security and its R&D method were discussed based on conclusion of the Space Basic Law. It was described at first that the Revolution in Military Affairs (RMA) that gives a change to character of war advances, and the importance of the satellite communications increases as its nucleus technology. Then the present and future use of satellite communications of the U.S. armed forces is described based on the published papers.

In the next, as the different points of studies after this from conventional studies, it was described to be more important not to let researchers think how to use the study result, not to squeeze the study items, and to continue R&D of the satellite communications by the government.

Finally, it was described that almost all necessary items are included in the conventional study items, but clarification of the study positioning is necessary, considering NICT as an example of national institute.

■Presentation at Study Group Meeting of IEICE in the End of 2009

A paper [4] entitled "Future Satellite Communications—Toward a Japan's Next Project—" was presented at the IEICE study group meeting of Satellite Communication Study Group. As for the contents, a WINDS satellite experiment made progress smoothly, but the next communications

satellite project such as a post-WINDS came in the time because a next term WINDS satellite project was not yet proposed. A candidate of a next term communications satellite project of our country was proposed based on that space development environment of our country changed by the enforcement of the Space Basic Law. In the presentation, motivation of suggesting the future communications satellite project was described and a super-high speed communications satellite "Gigabit-2" was proposed. Furthermore, application of the satellite technology, the technology to be developed and finally a method of national security related studies were described.

In addition, it was described that we should consider based on the Space Basic Law including changes from non-military affairs to non-aggression of space development purpose, reinforcement of competition in the international market of a space industry, and promotion of a satellite use information and communication network to contribute to nation life improvement. The degree of freedom of a study rises in particular markedly when based on non-aggression from non-military affairs. In other words, the technology development had been limited naturally to the R&D permitted in between the Japan and the United States agreement in 1990 by Japan-U.S. trade friction to be caused by Super Trade Law 301 and non-military affairs in the conventional R&D of satellite communications in our country. On the other hand, the national security related technology might be in danger to be inferior to other countries unless the R&D is performed with persistent effort. Therefore, it was described that the latest technology need to always be maintained and a future communications satellite design must make this reflect. Furthermore, it was described that a super-high-speed satellite is appropriate to be a future target, because it is thought that a high-speed network is necessary to prepare an information and communication network in future.

■ Presentation at the Journal of IEICE in the Beginning of 2009

References [5] is an article in the opinion column of the Journal of IEICE as the collected studies that mentioned above. In addition, the author developed these opinions on a discussion held at an AIAA-JFSC general meeting in References [7].

In the following part, I would like to discuss a method of R&D concerning national security. Since there might be technologies specified to the satellite communications, the satellite communications technologies specific to national security are enumerated for the brief review before discussing how to proceed the R&D.

◆◆ Satellite Communications Technology Peculiar to National Security ◆◆

The items of technology R&D related to national security including satellite communications technology are enumerated briefly. See details in Reference [7], where recent special situation is shown in detail later.

- Military communications satellite technology
 - High speed communication
 - ✧ The U.S.'s T-SAT was canceled, but it seemed to assume 2 Gbps satellite-Earth link and 10 Gbps inter-satellite link
 - Mobile satellite communication
 - Cluster satellite
 - ✧ Anti-satellite attack weapon
 - ✧ DARPA's Satellite F6 [8]. Because it seems to advance recently, it needs to pay attention it [9]
- Reconnaissance satellite technology
- Invulnerability technology
 - LPD (Low Probability of Detection) and LPI (Low Probability of Intercept)
 - CIA (Confidentiality, Integrity, Availability)
 - Measures for nuclear explosion [10]
 - ✧ Millimeter wave radio communication technology
 - Anti-Jamming technology

- Soldier-to-soldier communication technology
- Smart antenna technology
- Low Density Parity Check (LDPC) codes

Since new reconnaissance satellites are launched recently, it is mentioned below. The reconnaissance satellite program has been developed step-by-step generation first, second, third and fourth generation so far. The satellite called as Sigint and embarked a very big antenna of a diameter of 100m class seems to be launched. According to a book entitled "New U.S.'s Military Forces Changing Defense Strategy and Weapon System" by K.Ebata [11], this field has the highest degree of secret. An electronic intelligence satellite of NROL-32 as shown in **Fig. 1** embarks an antenna of a diameter of 100m, and was launched by a Delta IV Heavy rocket on November 21, 2010 [12]. Furthermore, a reconnaissance satellite called as NROL-41, probably a smaller satellite than NROL-32, is launched on September 20, 2010 by Atlas 5 rockets [13].

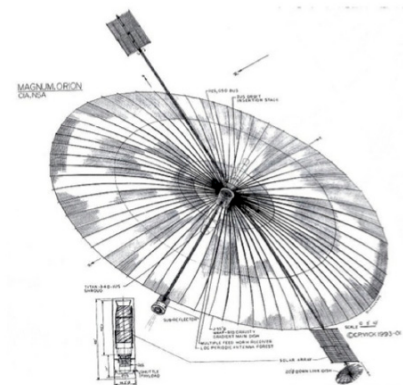


Fig. 1 Satellite like NROL-32 [12].

In addition, as for a military communications satellite, WGS (Wideband Global Satcom) seems to success greatly now. Mentioning specially, the allied countries moves to procure WGS by joint investment. There seems to be worry about decreasing demand of military communication using commercial satellites when large capacity military communications satellites spread. But, according to the recent news, Canada, Denmark, Luxembourg, the Netherlands, and New Zealand have agreed to joint investment [14].

It seems to be a future problem how our country does. But from the technology point of view, the target technology for R&D should aim at more future communication ability than WGS.

◆◆Method of National Security Related Research◆◆

The following description focuses on how to lead national security related R&D of space development or satellite communications. On that occasion, based on the papers presented so far, since such papers were written under the limitation of page numbers, only the summary was presented. Therefore I would like to describe a content of References [5] in more detail.

■Should Not Let Researchers Think How to Use Their R&D Result: Necessity of "Tacit Consent"

The space concerned persons has been always blamed so far, like "The reason of the thin public interest in the space development is due to the poor advertising method of the space concerned persons". In particular, when the space professionals are pointed out that how to use the result of R&D is obscure at the stage of proposing the research item or getting the budget, they have been made to think how to use it by squeezing their poor knowledge about space application. However, it was necessary to think about the space from a larger field point of view. In References [15], Mr. Katsuyuki Kawai said: "...We have depended too much on the efforts of the Japanese engineers who raised a space technology to preeminent level of the world? We have forced space scientists, researchers and experts to think the way of development and use of space? ...We must now change the Japanese national policy about space from its foundation...We must think about significance of space development from broader point of view. Politicians have certainly the responsibility that has neglected it." There was reflection to think the space as a problem of politics in the background of Space Basic Law.

Furthermore, in the technology R&D related to national security, it is regarded as arrogation that a researcher thinks how to use the result. How to utilize provided information is jurisdiction of specialized agencies having capability for high information processing. There might be a problem in

the security that important information is thrown away unless it is processed by a specialized organization such as Cabinet Intelligence and Research Office [16] in the case of our country, for example, in order to transform provided information to intelligence. Then there may be doubt how to start research theme, but this is just a matter that judgment is demanded from a wide field point of view. One of judgments is "the tacit consent". When a program of rocket development was started in Institute of Industrial Science, the University of Tokyo in 1950's, this program has never stopped through an argument whether it was a missile, although it is completely missile technology. Perhaps this is just "the tacit consent". In this way, "the tacit consent" is necessary in particular for a study related to national security.

To a detailed part, it is not necessary to investigate what to use this for limitlessly. All of arguments tends to be exposed to public recently because transparency is demanded. However, it is in danger for a study in national security. An explanation of "Such a thing is planned." and "Such a thing is developed." is given to Ministry of Finance at the time of budget acquisition. Therefore, information leaks out like drawing water with a colander. This means it is open to public what kind of thing is developed [17]. It is not to discuss it at an open place. In a discussion in Space Activities Commission, a discussion of cause pursuit for failure in particular should be careful. About a cause of rocket launching failure, the information such a position of the plumbing or thickness of an insulation cover should not express in form to answer a question from professors of committee member. Other than a matter of space development, there seems to be a public opinion that a nuclear power generation plant-related document should be opened entirely to the public because of an accident of a recent nuclear power generation plant. But it will be the problem that should deal carefully. In addition, a publication of an article of an avian influenza study is recently considered to be a problem [18]. But, this should be considered from the security point of view. An exhibition in anything is dangerous.

In the same meaning, there is a word that must not say. It is "Why the second position in the R&D field is not OKey?". In addition, not limited to the technology related to national security, the more advanced technology is, the more difficult to forecast how to use it is. There is the thing that is obscure how to use as mentioned in the previous time of this series like the relationship between successful experiment of radio wave by Heinrich R. Hertz and its practical use. The outlook for science and technology must be careful, not limited to national security.

A question occurs what responsibility of atomic physicists who create atomic weapon is, when researchers should not be let think how to use result of R&D. What was mentioned above asserts that we should reflect on rather oppression on the researches due to forcing upon researchers excessively so far. It would be suitable that we argue the big problem such as an atomic bomb at the other opportunity [2].

■ "Extraction and Reinforcement" Rather Than Research "Choice and Concentration"

It was mentioned in the previous time of this series that the choice and concentration of R&D theme should not be taken. This is why nothing would remain at last, if we stack discarding the things regarded as unnecessary by the principle of choice and concentration. A talented person of the field is lost whenever draining it off. This is because it becomes irreversible at a time when we need emergency [19]. It is pointed out that the choice and concentration is not good in a meaning of a portfolio of research in the previous time of this series column. Because a large amount of money is not necessary at an early stage of technology R&D, it is important to invest the R&D related to national security that cannot be found out how to use it. From this meaning the principle of the choice and concentration is not appropriate. It is not the case of space development, but the Eastman Kodak company performed a petition for bankruptcy [20]. The concerned persons point out with agrees the failure in 90's, about the cause that a company called a yellow giant tripped. One of the causes is said that the company has cut out one after another the businesses other than the film technology along a principle of "choice and concentration" by Chairperson, George Fisher, who came from Motorola. It is said that at that time, a species of future growth has been thrown to outside company [21].

Not to cut an R&D theme, while leaving many various researches, a method that a promising thing among them is picked up and is fostered may not discourage a researcher. How is an expression of "extraction and reinforcement" of R&D instead of "choice and concentration" in corresponding the measure above? In a word, it is important to make a flow of fund to reinforce fundamental researches in R&D related to national security.

■Necessity of Satellite communications Research by Government

The Japanese government will supply a communications satellite in a field of national security, because the Space Basic Law declares that an information and communication network using satellite is maintained and promoted to contribute to nation life improvement. In that case, the government need to promote a study of satellite communications, because the person in the government is absolutely necessary, who understands satellite as well as research.

On that occasion the tacit consent is particularly indispensable to push forward a study. For example, in a study of satellite-born antenna technology, only the moderate size of antenna to be necessary for a commercial communications satellite may be enough for the time being. However, it is necessary to research and develop larger scale antenna than one for the commercial satellite as shown in **Fig. 1**, because it has a possibility to develop into a reconnaissance satellite in the future. Besides, the government must have such a technology without announcing it because a secret degree is the highest. In addition, signal processing technology is important in reconnaissance satellite related technology as well as military communication in the satellite communications technology related to national security. Such a consideration is very important corresponding to the proposal that a national institute should focus on the national security related research.

◆◆Acquisition of Information and Its Treatment◆◆

The secret maintenance of the information is important in the national security related R&D. However, there would be no expansion of R&D and could not expect an influence effect of an investment if everything is classified in the 100 Percent. Because of research characteristics, it is always necessary to aim at improvement of performance and the next generation [22]. In this conjunction, it should take into consideration that 95-98% of classified information can be obtained by arranging open source information [16][23]. Therefore, R&D related to the national security is not surrounded by only classified information. Rather broad activity through the institution and so on could possibly be useful to make the R&D excellent.

It is natural to make a main part of system classified. Even if 50-70% of system performance is announced, it should still aim at the top-class performance among the institutions. In this instance, announcement of rather research method for obtaining optimum, maximum, or minimum than the value itself of performance is needed to level up the research.

Epilogue

According to the news paper on January 6, 2012, the expenditure of the U.S. defense is reduced for financial improvement, and the U.S. expects reinforcement of more role of allied countries [24]. Therefore, it seems that more advancement of ability for defense is demanded in our country. The author who is an outsider of the defense thinks that the acquisition of information and its circulation are the most important problems at this time, and importance of a military communications satellite playing central roles increases more and more and must be improved.

The author would like to try to challenge to a method of future R&D as well as the R&D method based on the East Japan Great Earthquake disaster of March 11, 2011 in particular.

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