

Web 2.0 and Satellite Communications Technology

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1. Introduction

Web 2.0 becomes a topic recently. But, I am not so familiar with Web 2.0 that I know only the following terms about Web 2.0:

- Long Tail
- Google
- Google organizes information in the world
- The scale that a computer of a search site is enormous
- GoogleEarth
- AdSense
- GoogleNet
- The far-side of a network
- Wikipedia

Therefore, it is not a purpose of this article to comment on these terms, but it is the principal objective, from the relationship of these terms point of view, to describe how the satellite communications technology should foresee the future in the Web 2.0 era and how AIAA-JFSC (Japan Forum on Satellite Communications) activity should be related it.

At any event, the Web 2.0 is new movement, and it is necessary for us to pay attention to it from a point of view whether a change would be occurred equal to the Industrial Revolution revolutionizing a form of social business⁽¹⁾.

2. What is Web 2.0?

The Web 2.0 is a concept that Mr. Tim O'Reilly proposed for the first time⁽²⁾, who is CEO of American O'Reilly Media which is a publishing company of a technology-related manual and book. A description about Web 2.0 is mentioned for the first time in Information and Communication White Paper 2006 of the Ministry of Internal Affairs and Communications⁽²⁾. It describes as follows: "Web 2.0 does not mean a specific service and technology at present, does not have a clear definition, but ... one of the points of a new tide by Web 2.0 is that it bases a web with a platform. A lot of users dispersed in society can tie through a network, gathering various knowledge, perform collaborations of various forms without any limitation from OS (Operating System), application and various devices of terminal. And businesses and services utilized such a collaborative system are realizing. At this point, Web 2.0 is not only a concept."

According to the Nihon Keizai Shinbun newspaper⁽³⁾, "Web 2.0 is a general term expressing the situation of the Web that bidirectional exchanges of information are enabled at the same time by the spread of high speed communication, and that evolves."

It enumerates three features: (i)Consumer individual has become an addressee of information as well as an addresser, (ii)Software itself performs services, and (iii)Phenomenon is spread that other sites can offer the related service without permission.

A company called Google positions at the center of the innovation. The Ref. (1) describes from a viewpoint how Web 2.0 and Google are tied. According to technical revolution historical view⁽⁴⁾ by Professor W. Brian Arthur of Santa Fe Research Institute, the information revolution, that began in the latter half in the 20th century, accompanies "a large-scale construction stage" for 10 to 20 years as a pattern of a revolutionary change equal to the Industrial Revolution. Everybody considered this "large-scale construction stage" as a construction of physical IT infrastructure called as "information superhighway" in 1990's, but what really became clear in the beginning of the 21st century is not an IT infrastructure made at large-scale construction stage but the I (information) infrastructure. Thereby "a revolutionary change related to information itself" is going to be occurred.

The essence of I infrastructure is not the logic of "the near side" which treats information at hand, but the facilities like an information power station which is placed at "the far side" of Internet. A company of Google noticed this for the first time, and has put an epoch-making great success from the establishment of a business during only 7 years⁽¹⁾. The driving force to bring this Web 2.0 is three major tides of Internet, cheap revolution by the Moore's law and an open source represented by Linux⁽¹⁾. Getting on these tides, Google is one of venture companies established in 1998 under an idea as "Google's mission is to organize the world's information and make it universally accessible and useful"⁽⁵⁾.

It is said that the whole information existed in the world is 5 ExaByte (5,000 Million GigaByte)⁽⁶⁾. Even Google has organized only 170 TeraByte (170,000 GigaByte)⁽⁶⁾. This equals only 0.0034% of whole information in the world. Google uses Internet and develops business, but its difference from such a conventional company is to perform business based on technology mainly. In other words, a network has a structure which brings profit automatically once it completes. As such a thing, omitting explanation of contents, the Long Tail phenomenon occurred by the small works need no expenses by the cheap revolution through the Internet. There are, in addition, AdWords and AdSense. Furthermore, there are "GoogleEarth" and "GoogleNet" which can be offered without user charges based on the advertisement income. The GoogleNet uses wireless LAN and offers the free communication system. If it successes, it seems in particular that GoogleNet will bring a serious influence on a conventional communication carrier. It is expected that it takes big influence if this spreads through the field of satellite communications.

On the other hand, watching an information power station from hardware point of view, it is said that Google uses the system which tied PCs linked more than 300,000⁽¹⁾. The number of computers seems to be enormous which are used as a database of search engine by Google, Yahoo, Microsoft, etc. Therefore, it is said that electricity seems to be enormous and nears five GigaWatt. They concentrates to install the computers in the mountain area along the Columbia river in Oregon, Washington and State of Montana, and optical cables of 640 Gbps links a computer center with the outside⁽⁷⁾.

3. Web 2.0 and Satellite Communications Technology

In fact, Web 2.0 and its point of contact with satellite communications technology seems to be few for the moment except that it offers telecommunication. Therefore examples are enumerated, considered to become the point of contact.

3.1 Cloud Computing On-Orbit⁽⁷⁾

Since the search engine uses a huge number of computers as described above and consumes great electricity, this system is that a group of computers itself placed on orbit and related computations are performed in the space, as shown in **Fig. 1**. Besides, it is advantageous that telecommunication line distance to the users would be shortened by employing LEO (Low Earth Orbit) satellites. This system concept was presented by Mr. J. Grady as a title of "Cloud Computing On-Orbit" at Space Application Working Group meeting of JUSTSAP2006 (Japan-U.S. Science, Technology and Space Applications workshop) held in Hawaii on November 13-16, 2006.

This concept would be an innovative idea different from the space solar power concept, because the conventional space solar power system generates electric power in space and transmits it to the Earth. In other word, the energy generated in space and consumes on the Earth. On the other hand, this idea proposes the solar power generates in space and use it in space also. As a result, the electric power consumption would be reduced on the Earth. Probably various innovative idea will need to be created on this concept. In addition, a super computer might be necessary. Although I have heard that a space born super computer is developed, it is really developed in JPL⁽⁸⁾.

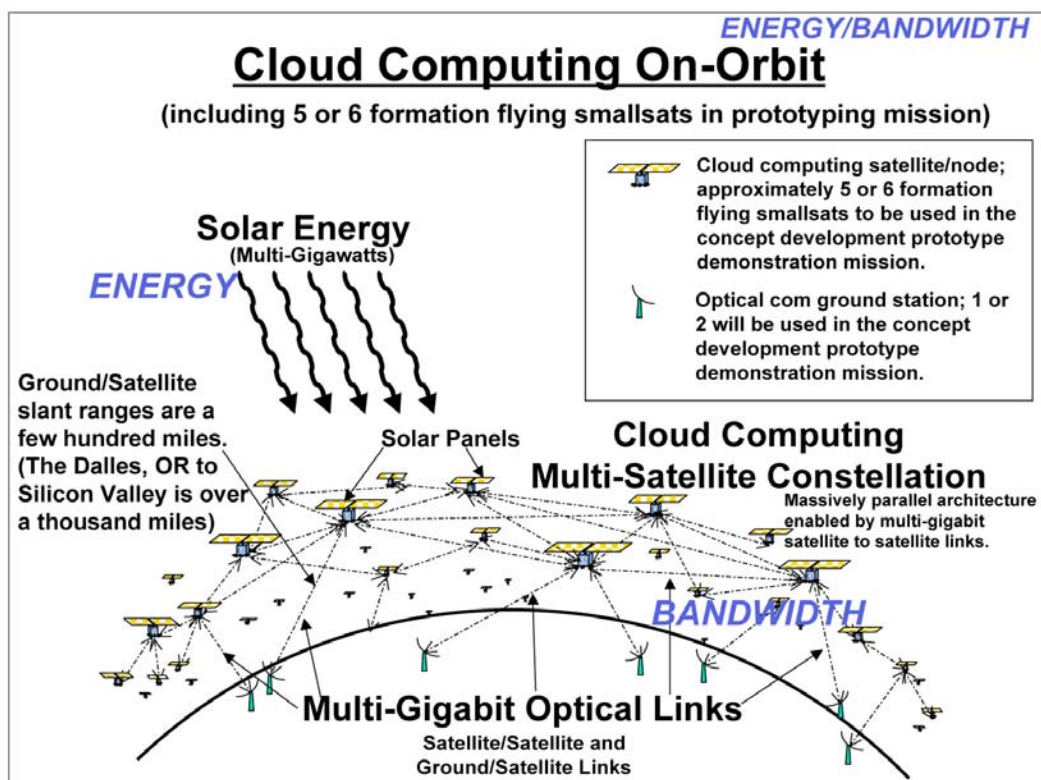


Fig. 1 Concept of Cloud Computing On-Orbit⁽⁷⁾.

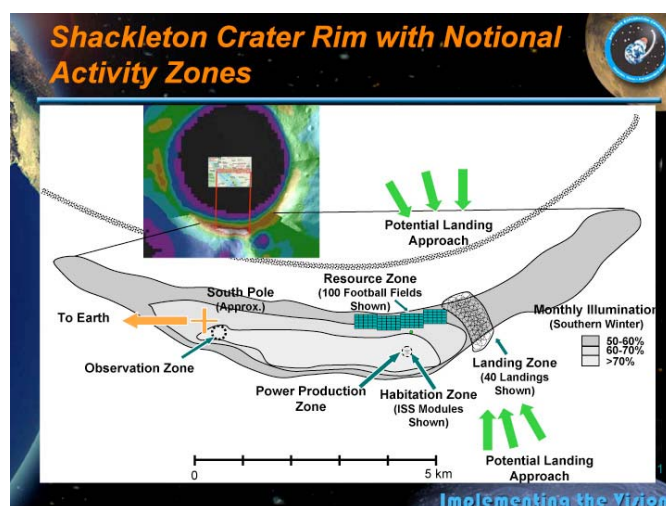


Fig. 2 NASA Proposed Lunar Outpost⁽¹⁰⁾

3.2 Use of Web 2.0 in Manned Lunar Community⁽⁹⁾

NASA aims at the reopening of manned Lunar activity by 2020⁽¹⁰⁾. An outpost shown in **Fig. 2** is studied where is placed on the Lunar south pole. Anyway, a manned base is constructed on the Moon and it assumes that the manned base will be expanded to the manned Lunar community of some scale in the very future and imagines that people staying in there come to use Web 2.0 by Internet.

Generally a community is constructed outside the society on Earth where Web 2.0 is configured shown in **Fig. 3** and let's constitute Web 2.0 on the community outside the Earth. If distance d between both societies is not so large and delay time is some seconds,

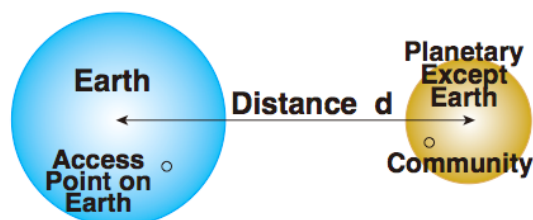


Fig. 3 Distance Between Earth and Moon.

a network can be constituted united with the Earth without a problem if the both way propagation delay is small enough. For an example, if the manned Lunar community is considered, the both way propagation delay is 3.4 seconds. A communication system as shown in **Fig. 4** is considered⁽¹¹⁾. Therefore, it will be no problem in a communication system between the Moon / the Earth in the manned Lunar community.

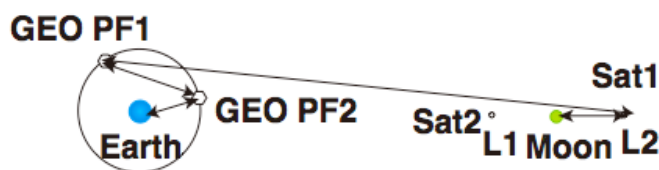


Fig. 4 An Example of Earth-Moon Communications System⁽¹¹⁾.

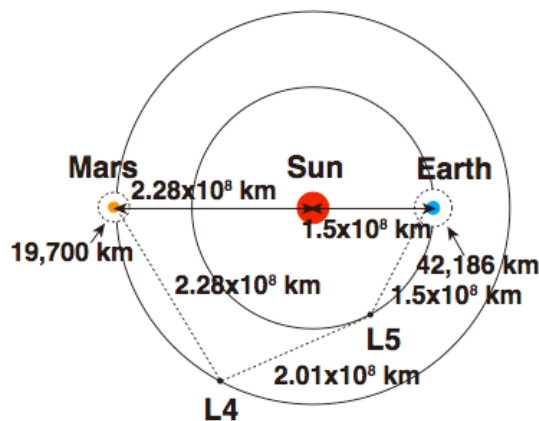


Fig. 5 An Example of Earth-Mars Communications System⁽¹²⁾.

3.3 Use of Web 2.0 in Manned Mars Community⁽⁹⁾

Next the case of manned Mars community is considered. A manned flight into Mars is a future story still for the time being, and it becomes about the future more and more that it is possible for manned community on Mars. But what we should do from an idea of Web 2.0 when it was possible for manned Mars community is interested from a point of view promoting technical development in the future.

A diagram shown in **Fig. 3** is considered again. In this case, both way propagation time is about 12 minutes in the minimum and about 42 minutes in the maximum, because the distance between Earth and Mars is about 1×10^8 km in the minimum, about 3.8×10^8 km in the maximum. Actually a communication system using Lagrange points can be considered as shown in **Fig. 5**, in order to avoid the Sun interference. So, both way propagation delay time is about 64 minutes. When we access Web 2.0 network on the Earth in this state from Mars, an answer can not reach until about 1 hour later. This will hardly bear use. Therefore at least a mirror database of search engine on Earth need to be constructed on Mars.

3.4 Requirement for Future Technology⁽⁹⁾

As mentioned above, a mirror database of search engine on Earth need to be constructed on Mars. To install it on Mars, the following technology problem should be resolved because it is an enormous system.

- Weight
 - It is 3,000 ton for 300,000 PCs each is 10 kg weight.
 - ✧ 300 transportations are necessary even if each rocket can convey 10 ton.
 - Weight need reduce to around 1/1,000 (gross weight of 3 ton).
- Electricity
 - 60 MW is necessary for 300,000 PCs each 200 W.
 - ✧ Reduce to around 60 kW for 1/1,000 (60 kW).
- Volume
 - It is 15,000 m³ for 300,000 PCs each 0.05 m³ (0.5 X 0.5 X 0.2 m).
 - The building neighbor of 100 X 30 X 5 m, need a gymnasium like building.
 - Must be made for 1/1,000, and is 4 m diameter X 2 m for 15 m³.

Therefore, weight, electricity and volume need be reduced to around 1/1,000.

Let's calculate how much communication capacity is necessary. It is said that information accumulated at Google's search engine site is called 170 TeraByte as described before. The transmission rate is calculated to match this information with database of search engine on the Earth. The transmission rate of 14 Gbps will be needed if the information of 170 TeraByte is refreshed in a day. Since the transmission rate can be established at present is about 100 Mbps with optical communication between Earth and Mars⁽¹³⁾, 140 times as much as present transmission rate is necessary. Since the transmission rate of 1 Mbps can be established by using millimeter and quasi-millimeter wave⁽¹²⁾, 14,000 times as much as present transmission rate is necessary. However, in spite of updating 170 TeraByte in a day, if the data base is updated every 2 weeks, quantity of updated data is 12 TeraByte per day. So the transmission rate is 1.124 Gbps. In this case, 11-1,100 times as much as present transmission rate is necessary. Therefore, it will be appropriate that the transmission rate is improved the order of 1,000 times as much.

Next, the whole quantity of Web data on Earth are considered to be transferred to the Mars. The information quantity that all of people create for a year can be estimated by a unit of 1 ExaByte (1,000Million GigaByte). It is said that the quantity that human creates next 2 years would exceed the quantity created in the past. We are now in so-called information explosion age⁽¹⁴⁾. The information quantity that humans have created by now is estimated to be 5 ExaByte, as mentioned before. If the whole quantity of information created in a year is about 2 ExaByte, and if this quantity is transmitted to the Mars for a year, the necessary transmission rate is 0.5 Gbps to transmit 16 ExaBit for a year (3.1536×10^7 sec). So 5-500 times as much as present transmission rate is necessary. This means the order of 100 times as much.

The technology in the future is required to improve the performance of both computer and communication. Let's consider the technologies to be developed to meet the future requirement mentioned above. Since the requirement concerns for the very future, we can assume the technology will be developed in dramatic change, because the space development leads new technology originally. In this situation, the quantum information science will play a main role for the technology development, because the quantum information pursues the relationship between information and energy⁽¹⁵⁾. This concern will fit the space requirement well. The quantum information technology will stimulate nano technology and bio technology. Therefore, quantum communication, nano and bio technology can be enumerated as candidate technologies to be developed in the future⁽¹⁶⁾.

The quantum communication technology will be enable to realize ultra-high speed communication over ultra long distance. If the computer applying bio technology will consume only noise level power, all of consumption power by 30,000 PCs will be small. If the nano technology provide a self repairable devices, the trouble of equipment would be minimum. In Japan, the forecast of science and technology using Delphi method is conducted every 5 years by the National Institute of Science and Technology Policy⁽¹⁷⁾. According to its forecast:

- Quantum communication technology: It is forecasted that the quantum communication technology whose transmission rate is as current optical communication will be realized by 2029. The grounds of one million times high speed as much is described in the Ref. (18).
- Nano technology: A self repairable space transponder will be realized by 2030.

- Bioscience technology: Very small power consumed computer, which works with thermal noise energy level will be realized by 2031.

4. Application of Web 2.0 to SJR Activity

In conjunction with Web 2.0, it is significant that the JFSC's activity makes match to the Web 2.0 movement in any sense. The following activities would be candidates:

- Positive use of a Long Tail phenomenon
- Practical use of a Google's AdSense
 - Open an SJR homepage to admit quotation in other personal homepages
 - To utilize SJR in a individual homepage and to admit to register an advertisement publication with AdSense
 - Contract or arbitrary contribution to reduce xx % of sales from Google to its elements in SJR
 - ✧ Need examination of a problem of tax
- Using Blog on satellite communications
 - How to use the minutes of an SJR Editorial Committee every month
- Work on satellite communications vocabulary commentary for Wikipedia
 - It includes many items of a satellite or satellite communications, but, according to an SJR Editorial Committee, to examine enough it and to cooperate with editing if it is necessary.

5. Conclusions

I talked based on a book written by Mochio Umeda "Web Evolution Theory –True Revolution Ahead" ⁽¹⁾ about movement to Web 2.0 at Space Japan Review editing committee meeting held in May, 2006. It is written in this book that Google aimed at organizing world information and knowledge. I feel that that is good and not good. But when I read book of Ref. (6), I recognize the Google can control information and knowledge, I think we have to see the Web 2.0 carefully. The Google like business may make the future of the communication business obscure. The satellite communication which is smaller than terrestrial communication business may be influenced severely.

Although we have to pay our attention to trends of Web 2.0, I remind you that we are very lucky to meet now a big movement equal to Industrial Revolution.

Finally, I thank members of SJR Editing Committee for their useful discussions.

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