

第 17 部

Asian Internet Interconnection Initiatives

第 1 章

Introduction

The Internet environment is now expanding rapidly in many countries and regions in Asia. With this growth, many people starts using the Internet not only for research, training, and education, but also for several areas which are not limited to computer communication technologies, such as product promotion, advertisement or "Electronic Commerce" type of use. For example, since 1995 the ASEAN countries has started using the Internet for monitoring acid rain and air pollution in countries and regions in the south east Asia. For the future of the Internet, the Internet community should encourage cooperative works using the Internet in the broad area of culture, languages, infrastructures, technologies, art works and other human activities.

In order to accelerate expansion of these kinds of cooperative works, it is important to share expertise between engineers in the area of the Internet technologies and people who are working for these activities. However, there are still some issues on infrastructures and technologies for information sharing in this region.

The major issue on the infrastructures is that the Asian countries do not share scheme and expertise on the Internet development, especially on the intra-Asia internetworking. Many countries and regions in Asia have global Internet connectivity now. Almost all of them have links connected to gateways in the United States. In early phase of the Internet development in Asia, this network topology was adequate and worked well, since almost all of the traffic was to/from sites in either the United States or European countries. However, as growing demands of cooperative works among Asian countries, it becomes popular to use the Internet as their ordinary communication channel. With this situation, many people now complains about its large RTT and lack of bandwidth of the intra-Asia Internet connectivity, because few Internet links were installed between the Asian countries. The major portion of the intra-Asia traffic is traveled via gateways in the United States; in other words, the United States acts as a hub for intra-Asia Internet traffic. It is obvious that this situation should be improved. For promoting the intra-Asia Internet development, we should make its good scenario, especially about its network design on its bandwidth, topology and datalink technologies. Furthermore, the scenario should include the scheme to

develop the Internet in the developing countries in Asia. Even in 1995, there are still some countries which do not have any connectivity to the global Internet. For these countries, the scenario should be a good guide to establish the first link to the Internet and to promote their local Internet development.

On technologies for information sharing in this region, we can use various kinds of applications including WWW, USENET news, and teleconferencing tools. As increasing users of these applications, their consumption of bandwidth today has become major portion of traffic on the Internet. However, bandwidth upgrade of the international circuits is generally very hard because of its cost. Therefore, new technical requirements are arising for using the Internet efficiently in the sense of bandwidth consumption. There are several possible solutions such as national cache servers, datalinks with data compression functions, or alternative link installations. However, researches and experiments on these solutions are required to evaluate if they are effective for the Asian Internet environment.

For these issues, there are several possible solutions, but it is not clear which approach is the best for its efficient development. The most practical way is to install testbed network, and to undertake collaborative researches and experiments on the network design and new technologies. In October 1995, the WIDE (Widely Integrated Distribute Environment) project which is a research consortium in the Internet area of studies and the JSAT (Japan Satellite Systems Inc.) which is a satellite communication company has started a testbed construction and a series of research activities on the testbed. This activities is called "AI³ Project." Research topics of the AI³ project includes network design for the future Asia-Pacific Information Infrastructure (APII), new technologies which enables IP multicasting over satellite communication channels and advanced routing method to use the channels efficiently, and promotions of the Internet technologies for countries in Asia.

第 2 章

AI³ Project Overview

The WIDE Project started the AI³ project in October 1995, in order to contribute, promote and encourage any related efforts toward achievement of the international information infrastructure in the Asia-Pacific region. In this section, the overview of the AI³ project is described.

2.1 Goals of the AI³

The AI³ project is primarily focused on technologies to provide an open Internet testbed for research and academic community in Asia. With the testbed, we are aiming to promote sharing expertise and knowledge among researchers and engineers in the area of the Internet technologies, to accelerate local Internet development, and to develop Internet technologies for utilizing several types of datalinks as the Internet connection. Goals of the AI³ project are as follows:

1. The AI³ project develops an information sharing infrastructure for accelerating more cooperative works among people in and around the Internet in the Asian countries. For this goal, the AI³ project installs its testbed network using the VSAT satellite communication channel. The details of the testbed is discussed in the later section.
2. The AI³ project develop an efficient Internet topology for the Asian countries. Furthermore, the AI³ project defines recommendations and requirements for both international Internet connections among Asian countries and the future APII from both technical and social viewpoints.
3. The AI³ project makes contribution for local development of the Internet in this region. There are still several countries where the Internet is not available. As a part of the testbed network, the AI³ project provides international circuits for these countries as their first Internet connectivity.

4. Using both existing Internet and the testbed network, the AI³ project makes efforts to develop more efficient transmission technologies for multimedia applications and new protocols, such as IP multicasting and IPv6. Moreover, we will try to develop new operation scheme to achieve efficient use of international Internet connections, such as multiple backup link operation or application based routing.

2.2 The Project Organization

The WIDE Project made a kick-off of the AI³ project, however, it is obvious that the goals of the project cannot be achieved only by the WIDE project. Therefore, the AI³ is organized as a joint research program with other research entities called the AI³ partners.

The WIDE project and the AI³ partners make efforts and work cooperatively to 1) share operation of the AI³ testbed network, 2) develop new technologies for an information sharing infrastructure among Asian countries, and 3) make efforts to define recommendations and requirements of the future APII.

From the view of the testbed installation, each AI³ partners is in charge of installation and operation of a gateway connected to the AI³ testbed. It includes procurement of equipment for the gateway, installation fee, and efforts to obtain licenses from appropriate local authorities to operate both the gateway and the VSAT earth station. The Wide Project and the JSAT are in charge of both the construction of the hub station in Japan and providing the VSAT bandwidth for this AI³ project.

Currently, the WIDE Project invited Institute of Technology Bandung (ITB) in Bandung, Indonesia, Asian Institute of Technology (AIT) in Bangkok, Thailand, and Hong Kong University of Science and Technology (HKUST) in Hong Kong as the AI³ partners. We are planning to add 4 more partners in Korea, Vietnam, Singapore, and Malaysia.

第 3 章

The AI³ Testbed Network

Since October 1995, the AI³ project has been constructing its testbed network. On this testbed, we will have a series of experiments. In this section, technical aspects of our testbed networks are discussed.

3.1 Topology of the AI³ Testbed Network

In the AI³ testbed network, we initially use the VSAT satellite links provided by JCSAT-3 communication satellite. The JCSAT-3 launched in August 1995 provides the Asian Zone Beam (Ku band) which covers several east and south east Asian countries and regions. The coverage of the beam is shown in the Figure 3.1. This figure also depicts the requirement of the size of the antenna at the earth station which can provide 2Mbps link.

For the AI³ testbed network, we can install up to 8 earth stations. Its initial network topology is shown in Figure 3.2. The AI³ testbed network is a star-shaped network; we will install our hub site, which is connected to the Internet backbone, at WNOG-Nara located in Japan. From the hub site, 2Mbps satellite links are spanning to earth stations at the AI³ partners' site in several Asian countries. Currently, earth stations at the current partners' location in Indonesia, Thailand, and Hong Kong are being installed. Other 4 earth stations in Korea, Vietnam, Singapore, and Malaysia are still in planning phase. We are expecting that all of the installation will be finished by the end of 1996.

Since the communication media of the AI³ testbed is VSAT satellite link, changing the network topology is much easier than the case we use terrestrial links. For seeking an optimal network topology of the testbed, the AI³ project makes statistical analysis of the link utilization. Based on the statistical analysis, we will redesign its network topology several times for more efficient use of the network.

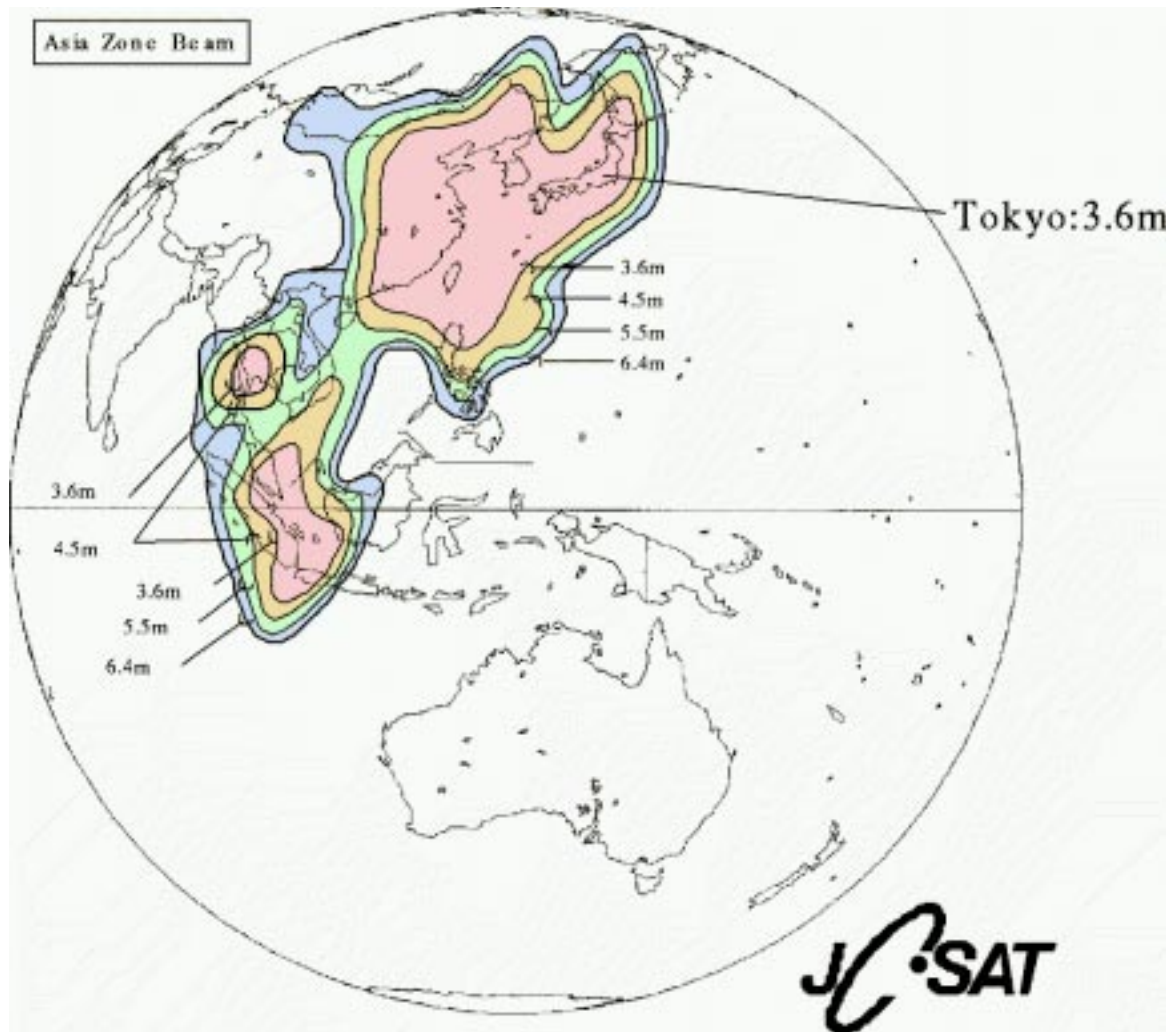


図 3.1: The minimum requirement on the size (diameter) of the VSAT antenna to get 2Mbps bandwidth using the JCSAT-3 Asian Zone Beam (Ku band)

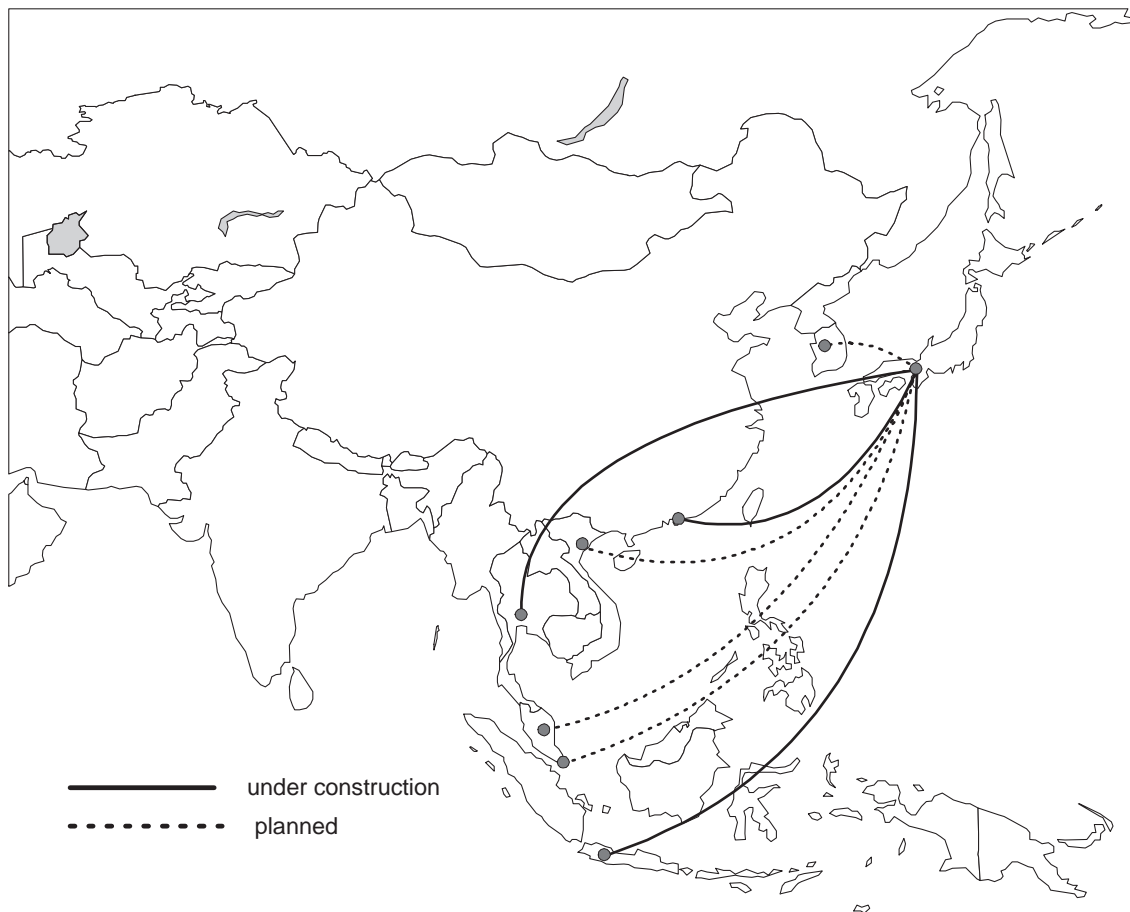


图 3.2: The initial topology of the AI³ testbed network. By the middle of 1996, AIT (Thailand), ITB (Indonesia), and HKUST (Hong Kong) are expected to join the AI³ testbed network. More 4 stations in Korea, Vietnam, Singapore, and Malaysia are planned.

3.2 WISH Technology

Generally, the VSAT communication channel is modeled as a point-to-point link. But the satellite communication is based on broadcast transmission mechanism. Considering the large RTT of the satellite link, we want to handle VSAT link as a broadcast media, especially for applications with IP multicasting (or Mbone).

Since 1994, the WIDE project has been developing several datalink drivers, called "WISH drivers," working with VSAT satellite channel in order to use the channel as an Internet datalink. With these drivers, we can use the VSAT satellite channel as both a point-to-point link and a broadcast media simultaneously. Each earth station can handle the VSAT satellite channel just as an Ethernet (but its bandwidth is limited to 2Mbps).

Currently, the WIDE Project operates a domestic satellite communication testbed network called "WISHbone" with these drivers. The WISHbone provides both 2Mbps point-to-point connections and a multicast channel from 1 to others among 7 earth stations geographically distributed in Japan. Through the WISH experiments, we confirmed that our WISH technology can improve the performance of both the Mbone type of multicast communications and applications based on bulk data transfers. In order to isolate Mbone traffic from the terrestrial nationwide backbone, the WIDE project uses the WISHbone as a major Mbone transport since 1995.

In the AI³ testbed network, we introduce the WISH drivers as a major datalink management software. Just like the WISHbone, we add the IP multicasting capability to the AI³ testbed network. Thus, several real-time multimedia applications based on the IP multicasting like VAT and NV can be used on the AI³ testbed network.

3.3 The Configuration of the AI³ Earth Station

The AI³ earth station is a gateway system for providing connectivity to the AI³ testbed network. Figure 3.3 shows the basic configuration of the AI³ earth station. Each earth station is configured with a router, a VSAT IDU, and a VSAT ODU. The VSAT IDU works as a modem to the VSAT channel, thus the interface of the IDU is V.35 or RS449. If we use the VSAT channel as a point-to-point Internet connection, we can use several types of gateway systems which can handle high speed serial link such as CISCO routers or UNIX workstation gateways with serial interfaces.

In order to use the AI³ testbed network with the IP multicasting capability, the router should be platforms which the WISH drivers can be installed. Currently, the WISH drivers can work on either the Sun workstations with SunOS 4.1.4 or IBM-PC compatibles with RISCOS serial line interfaces running under BSD/OS 2.0.1.

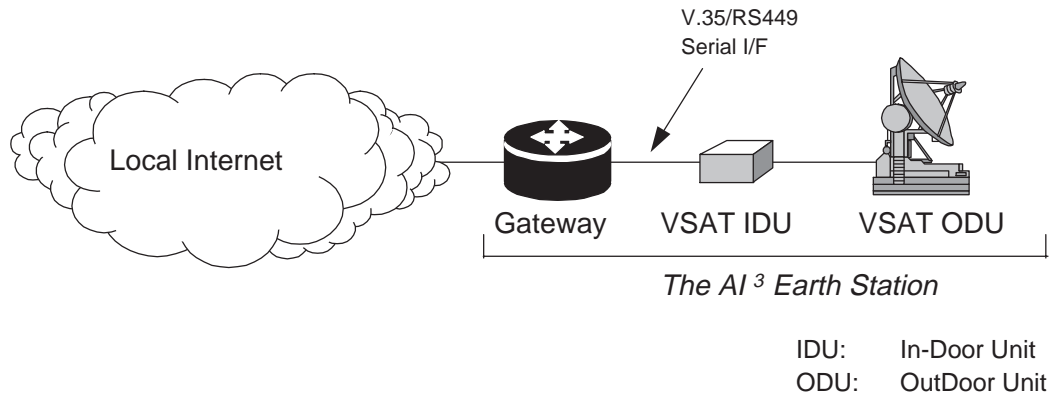


図 3.3: The basic configuration of the AI³ earth station.

3.4 License

The hardest part of the beginning of the AI³ project is "obtaining a license." In countries in this region, governments have many kinds of regulations to restrict international commercial communication services. Furthermore, the licensing process normally takes several months. For example, the JSAT who is an owner of the JCSAT-3 satellite must obtain a license for its commercial operation of the satellite from the Ministry of Posts and Telecommunications of the Japanese government. This licensing process normally takes about 5 months. Thus, we expect that the AI³ partners have to spare much time in 1996 to obtain licenses from the appropriate local authorities.

3.5 AUP

The acceptable use of the AI³ testbed network is limited to activities for achievement of the AI³ goals. In other words, the AI³ testbed is not AUP free. We define this AUP because the AI³ project is not willing to make any conflicts with local ISP development. The AI³ testbed accepts either traffic for the AI³ researches or support for the AI³ activities.

第 4 章

Research Plan on our Testbed

On our AI³ testbed network, a series of research activities is planned. In this section, several research topics we are planning are introduced.

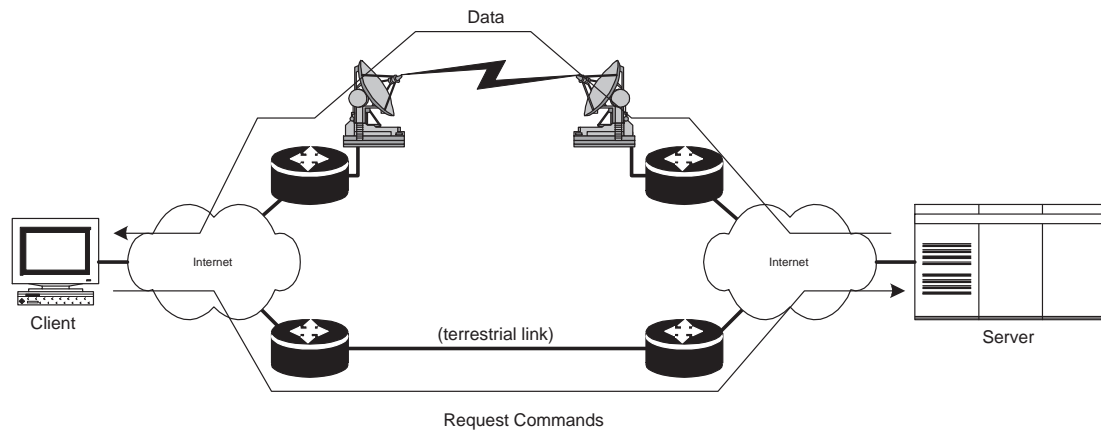
4.1 Link Backup Coordination

One of the major issues in the AI³ testbed network is to design and develop the international mutual connectivity backup method. Because of the rapid growth of the Internet users, availability and stable operation of the Internet connectivity has become more significant. Almost all of the countries in the Asia have direct connections to the Internet gateway sites, such as MAE-West or NAPs in the United States. However, there are few connections among the Asian countries. Hence, in the case that the link to the United States is down, these countries will lose their Internet connectivity. Even with links among the Asian countries, there is no coordination to use them as their backup connectivity to the Internet. This situation should be improved.

Throughout the AI³ project, we will provide the AI³ testbed for connectivity backup operation. However, strategies and requirements on the connectivity backup operation are still not clear. Thus, we try to define the strategies, then develop technologies to implement the strategies on the operational mutual connectivity backup method for the Internet in Asia. For this objective, the AI³ project plans several experiments using its testbed network. Especially, our experiments are focused on the topology and routing design of the AI³ testbed network, routing servers, and the policy routing implementation techniques.

4.2 Application Based Routing

Another technical issue is the application based routing technology. It is the major characteristics of the VSAT satellite link that its RTT is about 500ms. This large RTT makes significant impact on the operation of several applications. In general, this feature



☒ 4.1: The concept of the Application Based Routing. The data flow from the server to the client is detoured to the satellite link.

is not suitable for applications with interactive operations such as TELNET. However, several techniques to improve the performance in the application level is available. Some of the WWW clients establish several HTTP sessions in parallel with the WWW servers so that the large RTT is expected to be less significant. Therefore, applications with this kind of parallel data fetch capability can be used comfortably even on the satellite links. Of course, applications with bulk data transfers such as FTP can be used effectively on the satellite link if high throughput is guaranteed over the satellite link.

From the observation of many applications based on the server/client model, traffic from a server to its client is much larger than one from the client to the server. In many case, the client sends short request commands to the server, then server returns large amount of data for the client. We may use this unbalanced traffic pattern to improve the application level performance. For example, a method that carries the command from the client to the server via terrestrial links with short delay and returns the data from the server to the client via satellite links with large bandwidth may provide good performance for users of the application (see Figure 4.1). Especially, in the situation where the ratio of the unbalanced traffic is high, e.g., the Video-on-Demand service on the Internet, this method can be applied and provides better performance.

In order to accommodate this method to the Internet, the AI³ will develop and evaluate a new gateway system on which the application based routing mechanism is introduced.

4.3 Weather Monitoring and Link Bit Rate Control

As described in the last section, the AI³ testbed network is constructed with the JCSAT-3 Asian Zone beam (Ku-band). The beams in the Ku-band have less interference but more

rain attenuation rather than beams in the C-band. The VSAT link may be down in the case that it is heavy rain around the AI³ earth station. In the current design of the AI³ earth station, the rain margin is set 3dB, therefore, the 2Mbps VSAT link may be down with 20mm/hour rain. Since the rain over 20mm/hour is observed several times in the rainy season in the south east Asia, this kind of link down will occur many times in these countries.

With the satellite link characteristics, we can still use the link if we decrease the link bit rate from 2Mbps to slower rate (e.g., 256Kbps), even with heavy rain. The link bit rate where the link can be survived in the heavy rain depends on the rain. The heavier the rain is, the slower link bit rate we can use. Moreover, since the link is basically point-to-point, both end station of the link have to decrease the link bit rate synchronously. In the case that only the AI³ satellite link provides an Internet connectivity to a country, this kind of robust link operation is important in order to avoid connectivity loss.

In the AI³ experiences, we will develop an automatic link bit rate controller for rain degradation. Figure 4.2 shows the configuration of the link bit rate controller. In order to measure the beam power at the earth station, we can use a spectrum analyzer which has GPIB control port. The VSAT IDU we use has a control interface (RS232c) with which we can control the link bit rate by a computer. Based on the beam power monitoring, the controller changes the link bit rate automatically in order to avoid link down by rain. Furthermore, we add the weather monitoring box to the controller. The weather data can be used as hints for the control strategy implemented in the controller.

4.4 Global Testbed

We are going to use the AI³ testbed network as a part of several global testbed such as MBone and SixBone.

As described in the section 2.3, we introduce the WISH drivers as our data link management software. With the drivers, we can use the AI³ testbed network as an IP multicasting transport. We can expand the MBone testbed over the AI³ testbed network so that experiments using MBone can be conducted on the AI³ testbed network.

For the IPv6 developments, the global testbed network called "SixBone" is now under construction. The AI³ project will contribute for its expansion to the Asian countries using our testbed network.

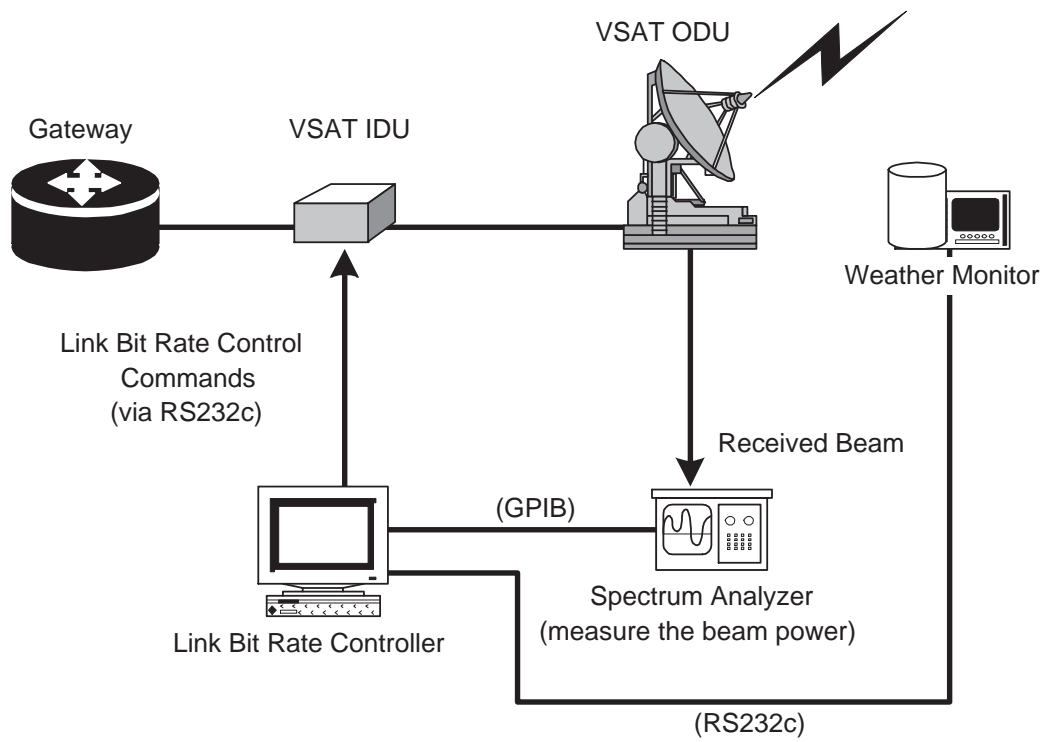


图 4.2: The Link Bit Rate Controller at the AT³ earth station.

第 5 章

Summary and its Current Status

The AI³ project started in 1995 is aiming at testbed construction and a series of research activities to accelerate cooperative works in and around the Internet in the Asian countries and regions. In this article, we introduce an overview of the project, technical aspects of the testbed, and several research activities in the project.

The AI³ project is still concentrating on construction of its earth stations at both partners' site and at our hub site in Japan. Currently, the VSAT earth stations in Indonesia, Thailand, and Hong Kong are under construction. We are expecting that the first link in our testbed network will be in operation by August 1996.

The AI³ project will report its activities mainly at APNG meeting¹. For sharing information, the AI³ project provides its WWW service². In the WWW service, we are providing several technical reports on our experiments.

¹Several documents about APNG (Asia Pacific Networking Group) are available at its WWW server at the URL <http://www.apng.org/>.

²The service can be reachable through our WIDE project home page at the URL <http://www.wide.ad.jp/>. Alternatively, you can directly access to the WWW page at <http://shika.aist-nara.ac.jp/research/ai3>.