RADIO RESEARCH LABORATORY

Ministry of Posts & Telecommunications

1985

OUTLINE OF RADIO RESEARCH LABORATORY (RRL)

Radio Research Laboratory whose activities date back to 1915 was established in 1952 as the sole research institute attached to the Ministry of Posts and Telecommunications.

Starting with a staff of 380 people and the annual budget of 180 million yen, RRL has currently a staff of 436 people and the budget of 4.2 billion yen and is known as one of the leading national research institutes of Japan.

The organization of RRL as well as the coverage and levels of researches has been changed extensively in order to keep up with the progress both in science and technology. In April 1985, the organization of RRL was fully rearranged to meet the requirements of the modern information society. The organization consists of nine Divisions, three Special Research Offices, two Research Centers and five Radio Wave Observatories (See next page).

The current research projects of RRL are classified into the following five fields: (1) Integrated Communication Systems (2) Space Communications, (3) Space and Atmospheric Science, (4) Remote sensing and (5) Frequency Standards. In addition to those projects, RRL is offering such regular services as the prediction and disturbance warning of the ionospheric propagation conditions, broadcasting of the URSIGRAM messages, vertical sounding of the ionosphere, operation of the world data center C2 for the ionosphere, dissemination of the standard frequencies and time signals, and type approval tests, performance tests and calibration services of radio equipments.

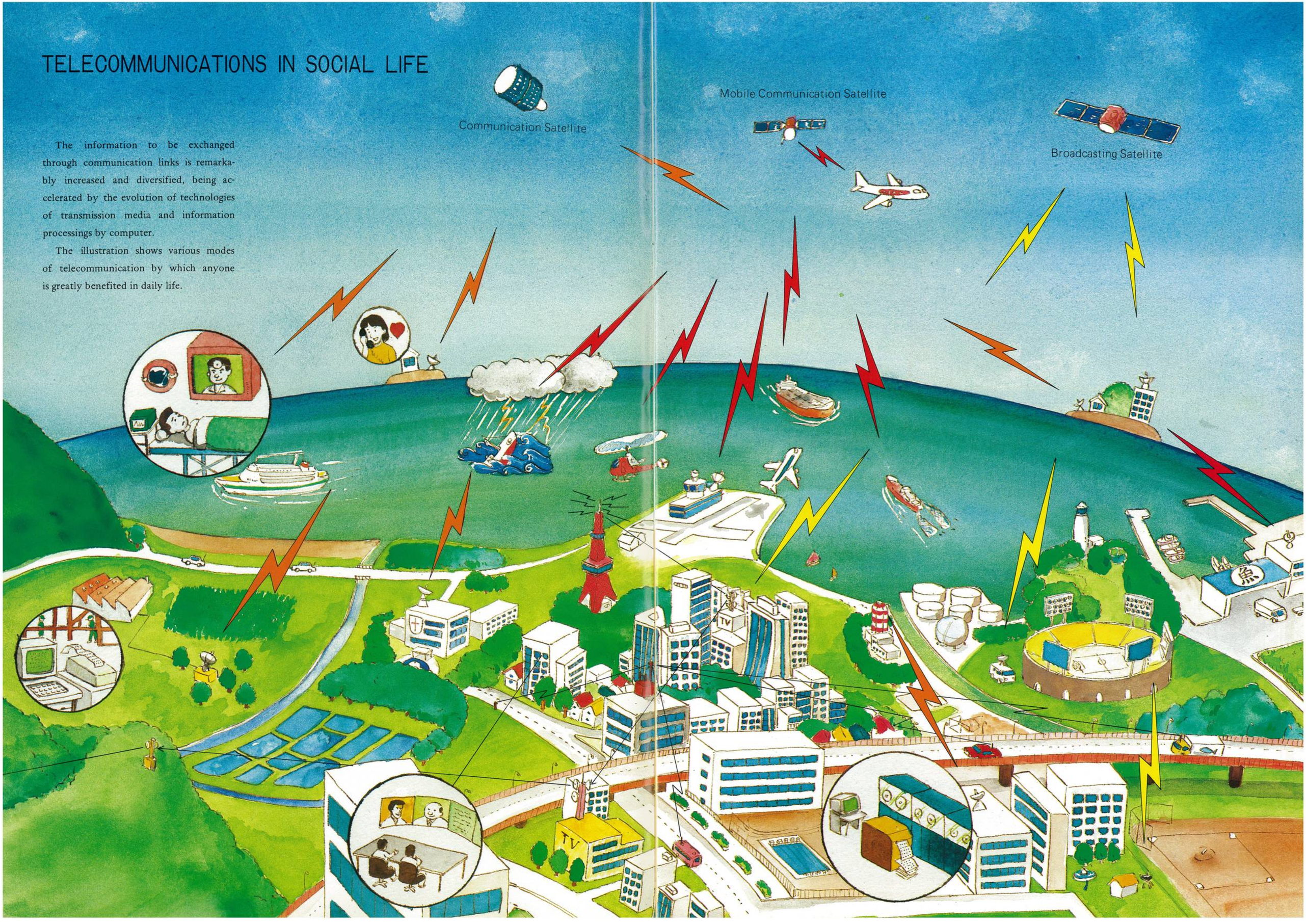
ORGANIZATION OF RADIO RESEARCH LABORATORY April, 1985

Director General	
Deputy Director General	
Associate Director General	
Administration Division	General Affairs Section Accounts Section
Planning Division	Planning Section International Affairs Section Technology Assessment Section
Technical Information Division	Information Management Section Computer Center Ionospheric Observation Section
Telecommunications Division	Computer Communications Research Section Communication Performance Research Section Broadcasting Technology Research Section Electromagnetic Compatibility Research Section
Space Communications Division	Satellite Communications Section Mobile-Satellite Communications Section Space Technology Section
Communication Technology Division	Speech Research Section Image Processing Research Section Digital Communications Research Section Antenna Research Section Applied Radio Physics Section
Radio Science Division	Magneto-Ionospheric Propagation Section Atmospheric Propagation Section Radio Propagation Media Section
Applications Division	Remote Sensing Research Section Optical Applications Research Section Space Environment Research Section Radio Applications Research Section
Standards and Measurements Division	Atomic Standards Research Section Frequency and Time Measurements Research Section Radio Measurements Research Section Frequency and Time Standards Section Calibration and Type Approval Section
Office for Space Science	
Office for Atmospheric Radio Science	
Office for Radio Physics	
Kashima Space Research Center	Administration Section Satellite Control Section Radio Propagation and Remote Sensing Section Space Communication Applications Section Radio Astronomy Applications Section
Hiraiso Solar Terrestrial Research Center	Radio Disturbances Prediction Section Solar Radio Research Section
	Wakkanai Radio Wave Observatory Akita Radio Wave Observatory Inubo Radio Wave Observatory Yamagawa Radio Wave Observatory Okinawa Radio Wave Observatory

TELECOMMUNICATIONS IN SOCIAL LIFE

The information to be exchanged through communication links is remarkably increased and diversified, being accelerated by the evolution of technologies of transmission media and information processings by computer.

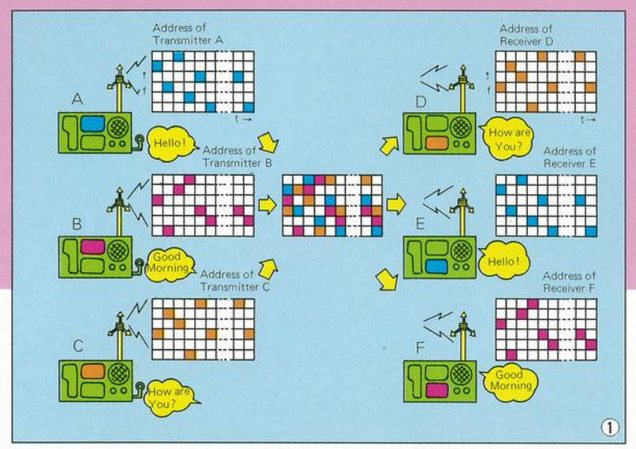
The illustration shows various modes of telecommunication by which anyone is greatly benefited in daily life.



INTEGRATED COMMUNICATION SYSTEMS

The role of telecommunications in modern societies is growing up year by year. It leads necessarily to the increase in the role of RRL which is going to extend his mission to the research and development of the integrated communication systems, on the bases of new organization of RRL reconstructed in April 1985.

RRL is now persuing researches in effective information processing, such as speech processing, image processing and computer network via satellite. Emphasis is also placed on researches to develop new communication systems with efficient modulation and transmission techniques, new broadcasting systems and measurement techniques of the electromagnetic environment.



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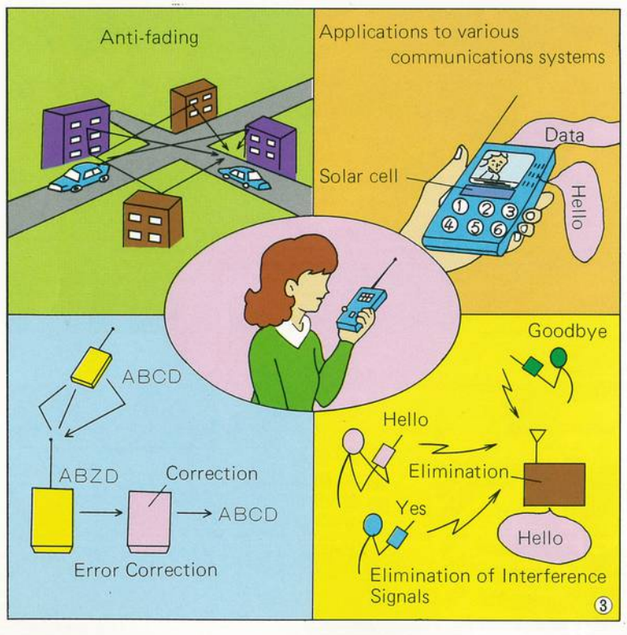

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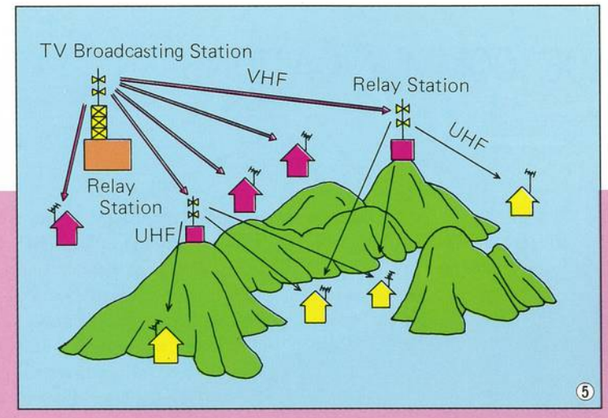
①② **Spread Spectrum Communication Equipment Effective for Land Mobile Radio System**

A new mobile radio equipment with a random and direct access capability has been developed to secure good quality of communication even in fading and interference environments. It will be used in many fields of communications, such as a mobile telephone, a police radio and a personal radio.

③ **Digital Mobile Communication System**

Digital modulation system can realize the encrypted voice communication and direct computer communication. The goal of researches is focused on the development of anti-fading method, voice coding and modulation techniques.


Offset System Synchronized System
(by Laser Disc System)
④



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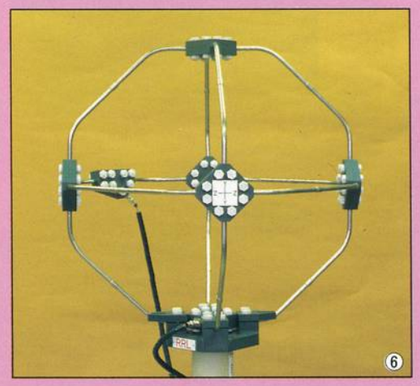
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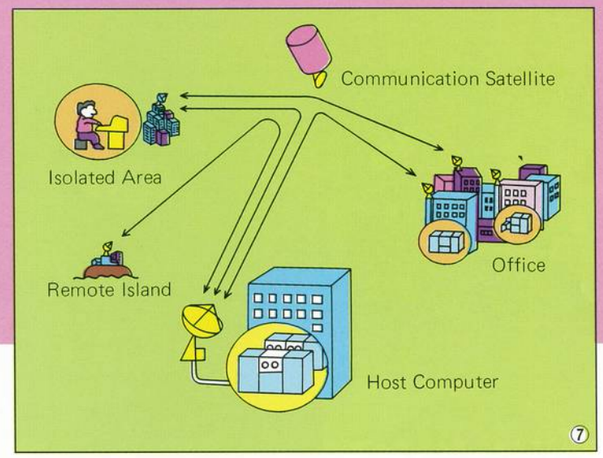

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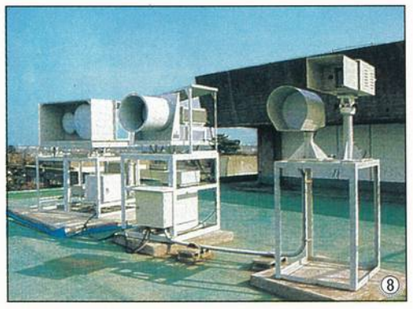
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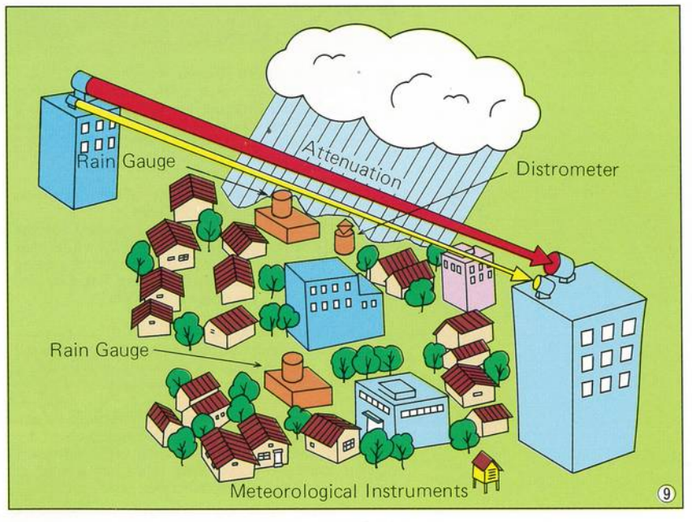

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④⑤ **Synchronized Carrier Television System**

This system is capable of improving the picture quality in comparison with the current offset carrier system, as shown in ④ and ⑤. It has also a great advantage that the same channel can be used repeatedly in overlapping service areas.

⑥ **Measurement of the Electromagnetic Environment**

For studying the electromagnetic environment, the characteristics of radio noises generated from electronic devices have been investigated. The levels of power flux density radiated from emitters have been surveyed in urban areas by using a specially developed system.

⑦ **Schematic Figure of Computer Network**

RRL is persuing researches in the computer network via satellite which makes it easy to access and connect the computers from any place.

⑧ **Millimeter and Light Waves Transmitting Systems**

246, 81.8, 141, 50.4 GHz Cassegrain antenna and 350 THz transmitting lens (left to right).

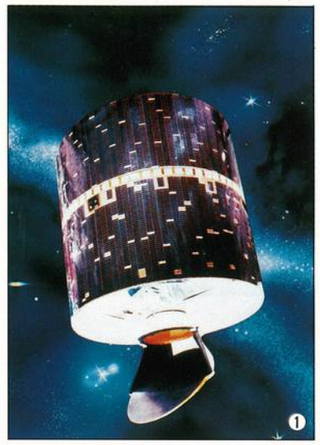
⑨ **Outline of Experimental Systems of Millimeter and Light Wave Propagation**

Experiments for clarifying rain effects on millimeter and light wave propagation characteristics are being conducted by using the system shown in ⑨.

SPACE COMMUNICATIONS

The CS-2 pilot plan led by RRL is successfully performed in participation of 52 private companies. The experiment of satellite broadcasting is also scheduled to be conducted by means of the direct broadcasting satellite (BS-2).

The Experimental Mobile Satellite System (ETS-V/EMSS) on board the ETS-V satellite is expected to provide the basic technology of the communication means for small vessels and aircrafts. RRL is also developing the satellite-borne multi-beam antenna, the satellite communication system in millimeter wavelength, and satellite attitude controlling system by means of ground-based laser transmitter.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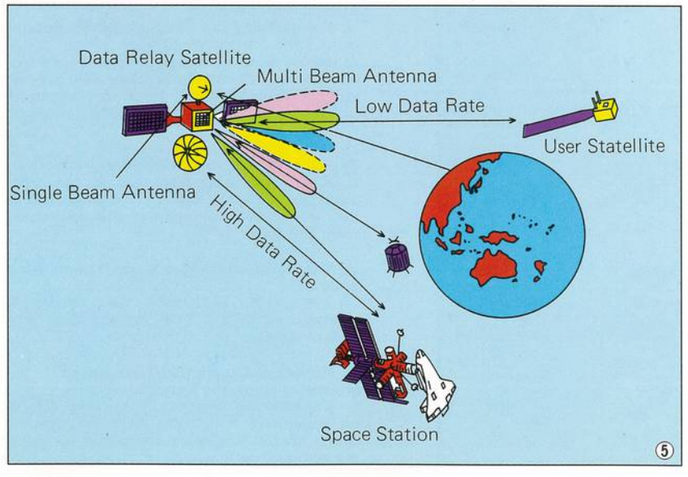

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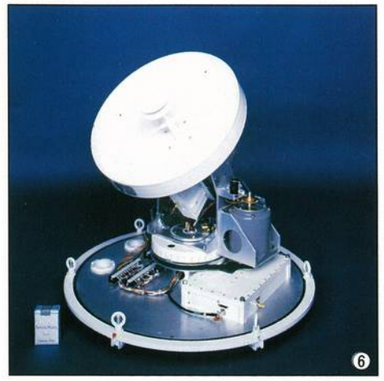
① CS-2
CS-2 is the first operational communication satellite in Japan which was developed on the basis of the fruitful results of CS experiment and was launched on Feb. 4 1983 by Japanese N-2 Rocket.

② Mobile Earth Station
The mobile earth station whose capacity is one voice channel via the SCPC system is mounted on the deck of a truck. The transmitter power is 17W and the antenna has a diameter of 1m.

③ Facilities for Satellite Communication and Broadcasting Experiments
The antenna on the right is used for the experiments using CS and CS-2, while that on the left was used for experiments using the Medium-scale Broadcasting Satellite for Experimental Purposes (BSE: Yuri).

④ Multibeam Array Antenna
An S-band multibeam antenna of phased array type having 19 elements is capable of scanning 19 beams simultaneously.

⑤ Concept of Multibeam Data-Relay System
A geostationary satellite implemented by a multibeam antenna provides efficient means for multiple access data relay between each of low-orbiting spacecrafts and an earth station.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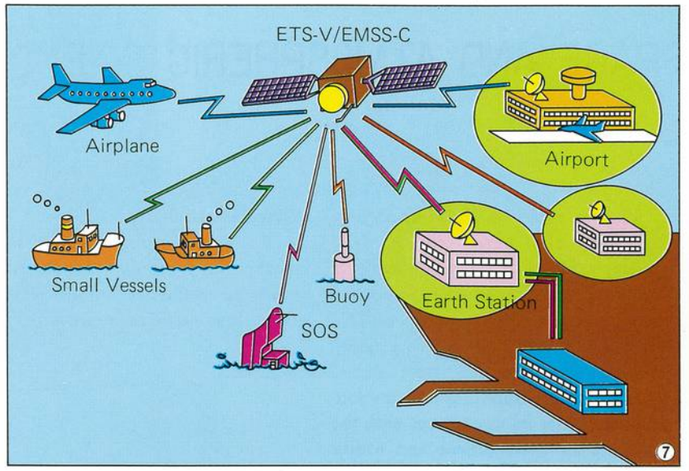

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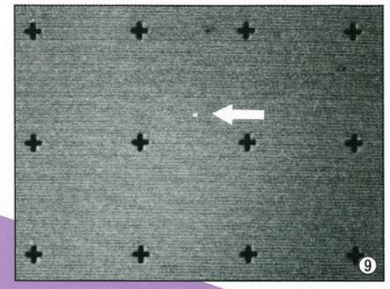
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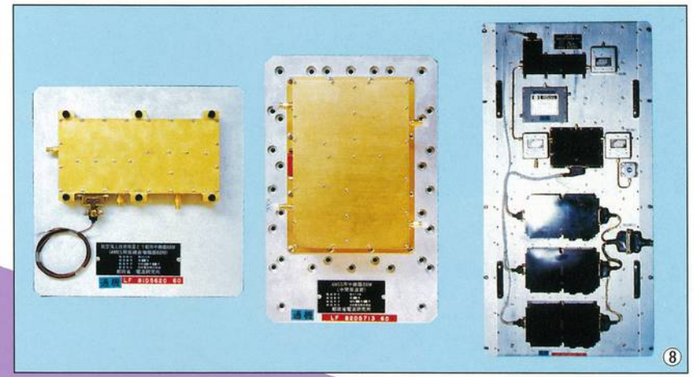
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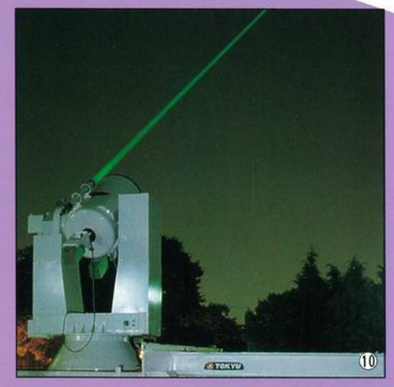
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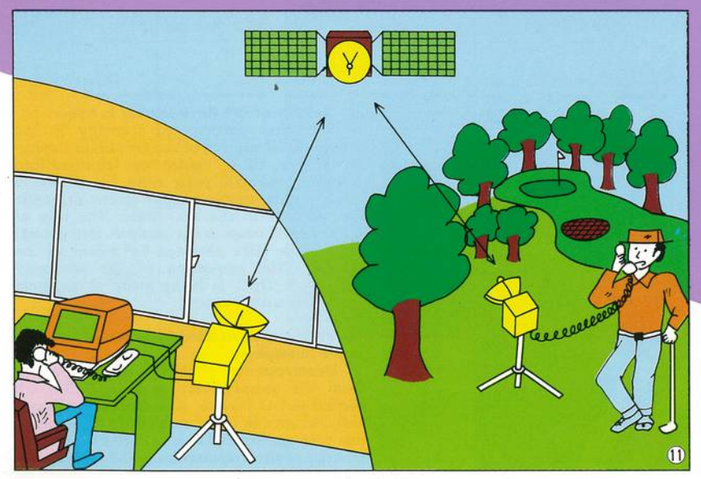
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⑥ Antenna for Small-sized Ship Earth Station
An antenna to be equipped in a radome is 64cm in diameter, 60cm in height and 39kg in weight.

⑦ Concept of Mobile Satellite Communication Experiments using ETS-V
An Experimental Mobile Satellite System (EMSS) to be boarded on the ETS-V satellite is being developed for the purpose of establishing communication links of telephone, facsimile, telex, and data collection between coastal earth stations and small ships or airplanes.

⑧ Bread-board Model of Transponder
A bread-board model of ETS-V/EMSS transponder was developed on the basis of researches made so far.

⑨, ⑩ Laser Beam Transmission over an Extremely Long Distance
Experiments of laser transmission between the earth and geosynchronous satellite are being conducted to acquire the know-how for laser communication in space.
⑨ An example of laser spot image detected by the vidicon camera on ETS-III.
⑩ The ground-based laser station.

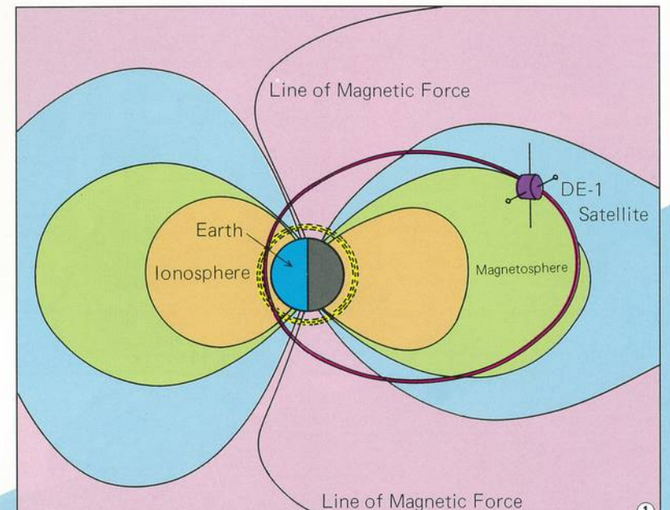
⑪ Challenge to Millimeter Wave Satellite Communications
A millimeter wave personal communication system using a satellite is proposed as a candidate for the future satellite communication system on the basis of preliminary examination.

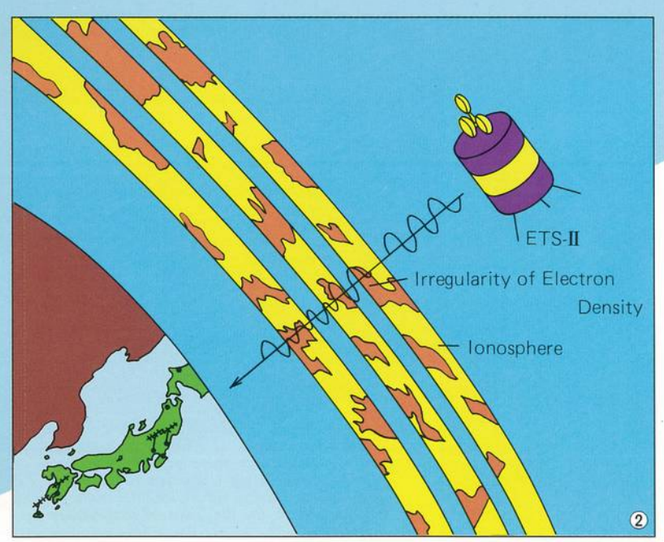
SPACE AND ATMOSPHERIC SCIENCE

Various types of disturbances arising from the solar activities and arriving at the earth's environment give influences upon the propagation of the radio waves which are used for TV broadcasts, HF and satellite communications and so on.

Information about space environment increases its importance with the advances in development and utility of space techniques.

For those purposes, the sun and the earth's environment are monitored with the satellite techniques as well as the ground-based techniques.



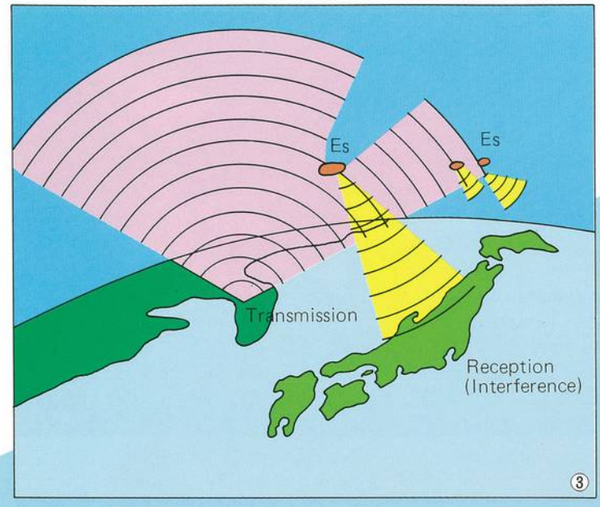


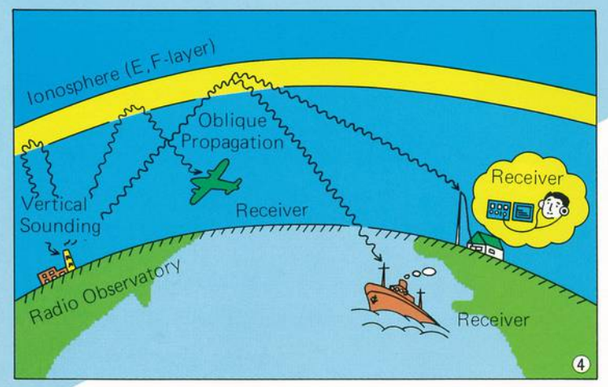
① Monitor of EM Environment in Space

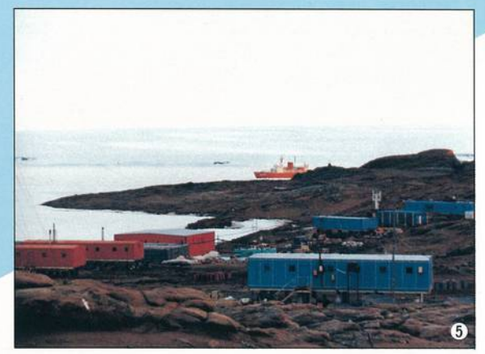
RRL has participated formally in the international project of the Dynamics Explorer Satellite, DE-1, which was launched into a highly eccentric polar orbit by NASA in 1981 in order to monitor the electro-magnetic environment in the near-space. The role of RRL experiments is to analyze the natural radio noise data obtained by means of the satellite. The acqusition of the telemetry data from DE-1 is being made at Kashima Space Research Center.

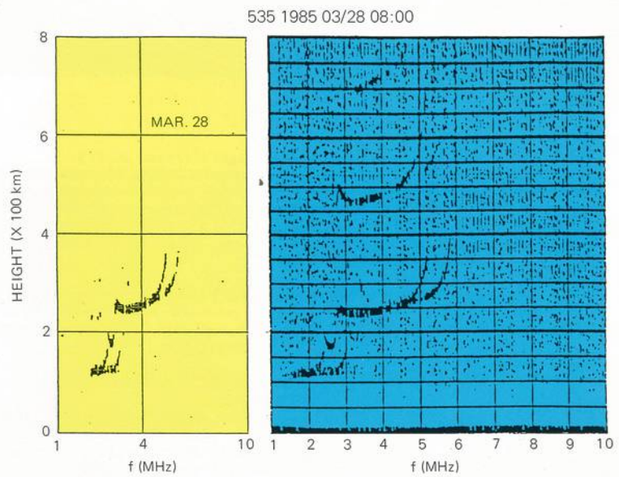
② Observations of Satellite Scintillations in the Ionosphere

Measurements of VHF signals emitted from the geostationary satellite ETS-II are carried out at Hiraiso, Kokubunji, Yamagawa and Okinawa in order to identify the anomalous propagation and to investigate the characteristics of the irregularities in the ionosphere.









③ Anomalous Propagation of VHF Radio Wave via Es Layer

TV reception is often disturbed in summer by the interference of foreign VHF radio signals propagated via the sporadic E layer. In order to investigate the phenomena, the monitoring of FM broadcasting signals is being made at each local Observatory.

④ Ionospheric Oblique Sounding

Ionospheric oblique sounding network is composed of five sounders installed at Wakkanai, Akita, Tokyo, Yamagawa and Okinawa Radio Wave Observatories. The characteristics and variations of the ionosphere as well as the usable frequency range for radio communication circuits in and around Japan can be obtained on a real time basis by receiving the echoes from the sounders.

⑤ Observations in Antarctica

Items of the observations which have been made by RRL at Syowa Station since the IGY include the ionospheric sounding, VHF Doppler radar for auroral study, riometer, HF field strength, omega radio wave and ISIS telemetry reception for topside sounding and VLF emission observation.

⑥ Ionogram Scaling with Computer

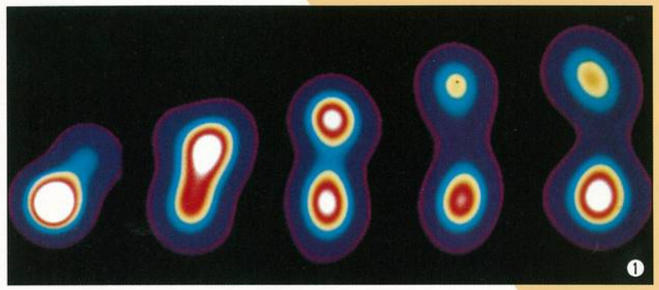
An automatic extraction of ionospheric parameters from ionograms is studied with computer. The figure on the right shows an example of observed ionogram, while the figure on the left shows an example of the noise reduced ionogram through computer processing.

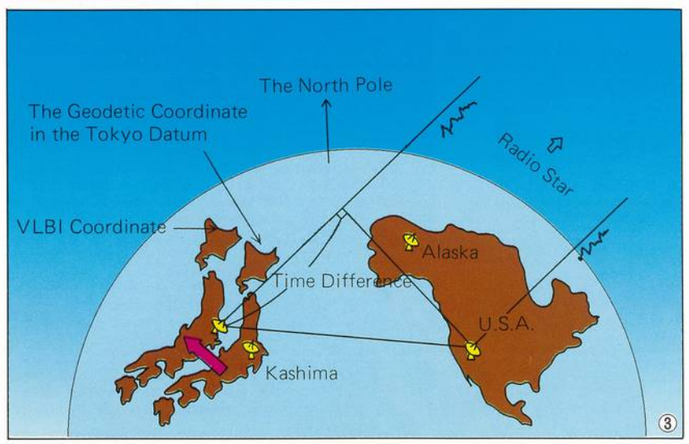
REMOTE SENSING

In recent years a rapid progress has been made in the field of remote sensing, which is one of the major research themes in RRL.

RRL is carrying out or planning various researches in monitoring the terrestrial environment and in exploring resources of our planet by means of the acoustic and electromagnetic waves including light.

The system of Very Long Baseline Interferometry (VLBI), having a wide application to the geoscience and astronomy, was established in 1983 at Kashima Space Research Center, which now takes an important part in the international VLBI experiment in a global scale planned by NASA.

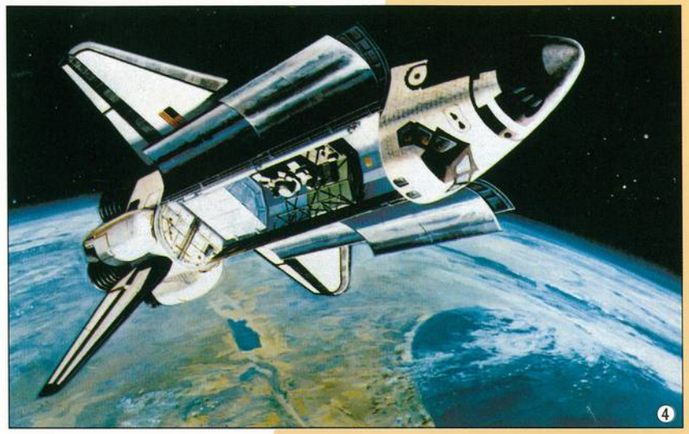


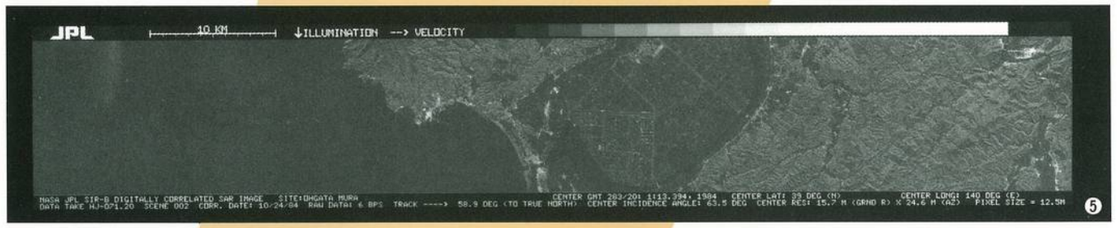


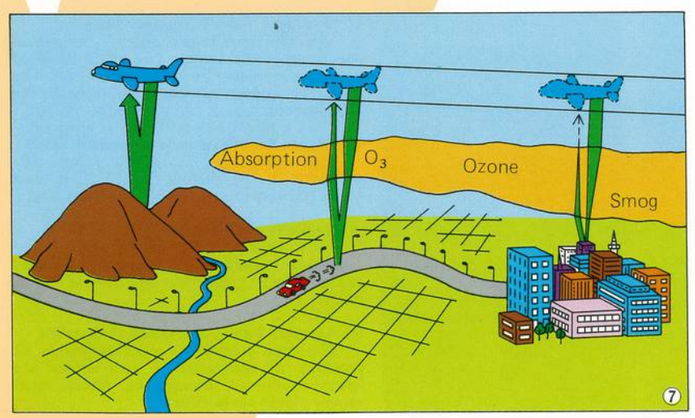
① **Radio Images of Quasar 3C-345**
A series of radio images of quasar 3C-345 which is used for VLBI observation shows a very large speed of expansion of nucleus and ejected gas. This photo is taken almost every year at Owens Valley Radio Observatory, CIT.

② **Antenna for VLBI Experiments**
The 26m parabolic antenna with a beam-width of 0.08 degree at 8 GHz is used for the VLBI experiments.

③ **Concept of the VLBI and Recent Result of Observation**
The baseline length between two VLBI stations can be determined with an error of less than 3cm by analyzing the difference of arrival times of the radio star signals. Recent VLBI observation shows that the position of Japan Island should be corrected from the present position to a position toward north-west above the sea level by 860.88m in the geocentric coordinate.







④ ⑤ **Synthetic Aperture Radar**
A Synthetic aperture radar (SAR) is a high resolution microwave imaging radar and is expected to become one of the major remote sensing tools in the future. RRL has participated in the Shuttle Imaging Radar B (SIR-B) program with the space shuttle launched by NASA in October, 1984. The image of Ohgata-mura and its vicinity (a typical rice field) in Akita Prefecture taken by SIR-B are shown in ⑤.

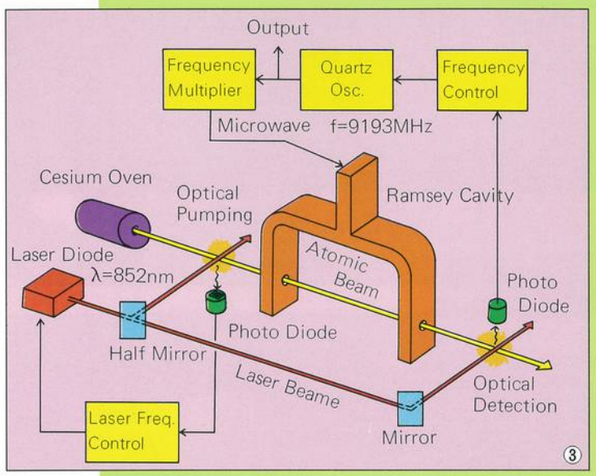
⑥ **RASS Radar**
Radio Acoustic Sounding System (RASS), as a ground-based technique to observe the tropospheric wind and temperature profile up to an altitude of about 1km, is expected to be effective for forecasting the distribution and movement of air pollutants.

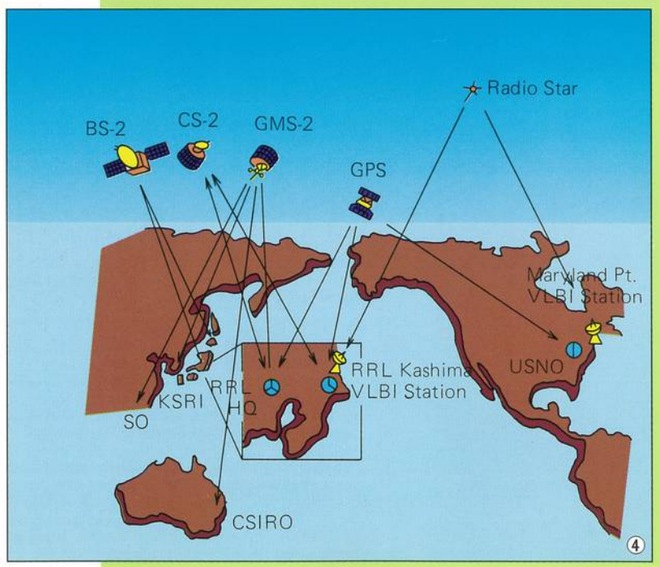
⑦ **Remote Sensing of Atmosphere with Laser**
A nadir-looking airborne lidar has been developed to monitor local ozone distributions. Solar radiometer with infrared laser heterodyne detection is also under development to measure several trace gases.

FREQUENCY STANDARDS

Correct and precise time and frequency is indispensable for the modern daily life based on advanced science, technology and industry.

RRL is responsible for determining and keeping national standard of frequency as well as the Japan Standard Time (JST) by using the cesium atomic frequency standard. In order to meet the growing social demand, researches are being carried out for attaining higher accuracy in the standards. RRL is also persuing researches in international time comparison by using various methods including the signal transmission via satellite. The results of comparisons are reported to International Time Bureau (BIH) for contributing to the determination of Coordinated Universal Time (UTC).





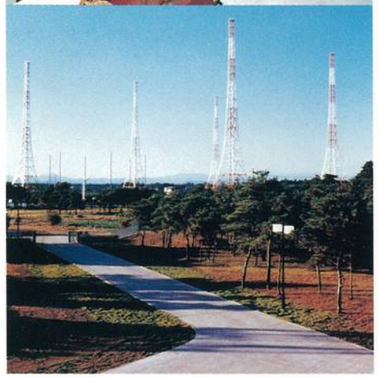
① **Hydrogen Maser Frequency Standard**
The hydrogen maser which is known as the most stable atomic frequency standard has been operated in RRL since 1966. The maser also plays an important role in the VLBI system.

② **Cesium Beam Frequency Standard**
The cesium atomic clock whose uncertainty is approaching 1×10^{-13} is used as the primary time and frequency standard.

③ **Optically Pumped Frequency Standard**
As a candidate for the future primary frequency standard, the optically pumped cesium beam frequency standard is under study.

④ **Accurate Time Comparison via Satellite**
The time comparison experiments in an accuracy of the order of nano-second are being conducted among the far-separated atomic clocks via satellite.

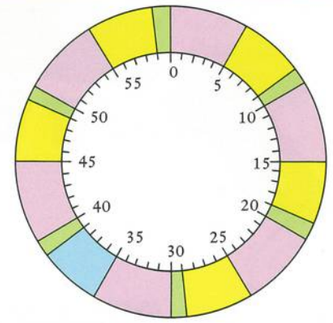
REGULAR SERVICES



◀ Type Approval Tests for Radio Equipments and Calibration of Equipments for Measurement
Radio equipments which are indispensable for securing the safety of human life and are related to the utilization of radio spectrum are legally obligated or recommended to obtain the type approval. The performance tests and the calibration service of equipments for measurement and monitoring are offered upon request.

Routine Ionosphere Sounding ▶
The ionosphere sounding at vertical incidence has been conducted for many years on a routine basis at five radio wave observatories of Wakkanai, Akita, Kokubunji, Yamagawa and Okinawa as well as at Syowa Station in Antarctica.

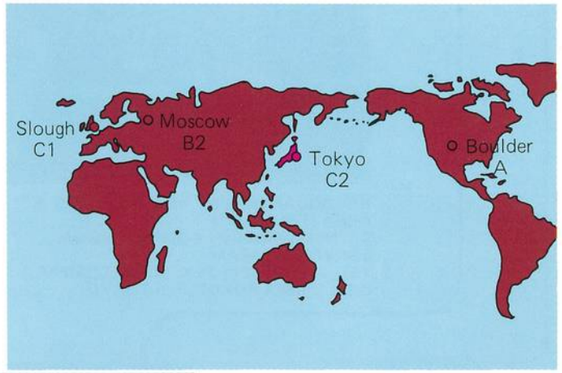
◀ Dissemination of Standard Frequency and Time Signals
RRL takes the responsibility for determining and disseminating the standard of frequency and time as well as the Japan Standard Time (JST). The transmitting frequencies of the signals are 2.5 MHz, 5 MHz, 8 MHz, 15 MHz, (JJY), and 40 kHz (JG2AS).



1,000 Hz Modulation
Non-modulation
No emission
Station Announcement

JJY Hourly Broadcasting Schedule

World Data Center C2 for Ionosphere ▶
Being designated as the world data center, RRL keeps the ionospheric data sent from observatories mainly in Asian and Oceanian regions, and exchanges the data regularly with other centers. Such data are open to the public.



World Days Service and URSIGRAM
RRL, as the Western Pacific Regional Warning Center of the URSIGRAM, issues radio propagation warning and broadcasts the URSIGRAM messages everyday at 10.415 MHz and 15.950 MHz.

Computer Center ▶
The central computer system (ACOS-850/10) offers high grade services even to the Centers (Kashima and Hiraiso) and to Radio Wave Observatories through the intelligent terminal.

Publications

1. RRL News (in Japanese) Monthly
2. RRL Annual Bulletin (in Japanese) Annually
3. Review of the Radio Research Laboratories (in Japanese) Quarterly
4. Journal of the Radio Research Laboratory Thrice a year
5. Monthly Radio Propagation Prediction (in Japanese) Monthly
6. Ionospheric Data in Japan Monthly
7. Standard Frequency and Time Service Bulletin Monthly
8. Catalogue of Data in World Data Center C2 for Ionosphere Annually
9. Ionospheric Data at Syowa Station (Antarctica) Semi-annually
10. Data on Topside Ionosphere Iregularly