

National Report Updates of Japan

H. Nishiguchi, Japan GPS Council

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1. National Activities

a. Time / frequency distribution activities

The services of the Japanese national standard time and frequency are conducted by CRL (Communication Research Laboratory, a state-run Institute) which routinely uses Cesium atomic clocks, linked to the international atomic scale (TAIUTC). CRL is a member of CCGTTS (*), plays a role of GPS Common View Program, and works for TAI (International Atomic Time) GPS Time Transfer Network organized by BIPM (Bureau Int'l des Poids et Mesures) as the main node of Asia and Oceanic region.

(*) CCGTTS : CCDS (the Consultative Committee for the Definition of the Second) Group for GPS Time Transfer Standardization

Since June 10, 1999, CRL has been providing its dissemination services of the standard time and frequency (Local UTC), through a newly established broadcasting station using 40kHz long-wave frequency, and the 60 years old historical service system using short-wave frequencies was phased out at the end of March, 2001. CRL encourages wider utilization of the above new services and the use of GPS-based time and frequency which are expanding in telecommunication business fields in Japan.

b . Survey/ Geodesy/ GIS activities

(1) GPS fixed reference stations network, GEONET:

The Geographical Survey Institute (GSI, a governmental agency), responsible for maintaining the geodetic control point network in Japan, has already completed, by the mid. of 1999, the establishment of a network of 947 continuous GPS fixed reference stations throughout Japan, named GEONET (GPS Earth Observation Network). This network is routinely used, as one of the most basic tools, for the crust movement monitoring, contributing to the swift restoration countermeasures against natural calamities, and also will be used for surveying and mapping. Further, GSI is promoting a project to extend GEONET to 1,200 stations within fiscal 2003.

(2) Disaster management::

Besides, in order to make provision for the recent possible risks from volcanic activities and for seismic active events such as the Tokai earthquake swarm zone, these GPS-based reference stations have been reinforced to the total of 1,022 stations, in which mobile GPS observation units with solar panel, wind generator and satellite communication devices are included.

The other relevant universities and laboratories also continue to run a number of their own GPS based and some of GLONASS -based reference stations for contributing seismic active research.

(3) New Geodetic System of Japan :

These reference stations of GEONET meet with World Geodetic System (geocentric system) standard, and GSI has provided transformation parameters from Tokyo Datum, which was the traditional primary geodetic standard being used in Japan since more than 100 years ago. In consequence of the successful GEONET establishment and GPS based precise monitoring activities for nationwide land scale, Japan decided to change the geodetic system from Tokyo Datum to the new coordinate system, i.e., ITRF94 standard which is internationally common. The named "Geodetic Coordinates 2000" has been enforced from April, 2002 as the "Japanese Geodetic Datum 2000 (JGD2000), of which outline are as follows;

- Referring to global reference frame ITRF94 (International Terrestrial Reference Frame), and GRS80 ellipsoid for geographical coordinates.
- Geodetic network based on VLBI and GPS (GPS-based control points).
- Geoid height data set is provided to determine orthometric height from GPS observation

(4) Data from GEONET for post processing and for real time kinematics (RTK) positioning :

Data obtained by GEONET for post processing has been provided to researchers and surveyors through Internet, and currently GSI has added its real time data service via the server control center co-operated by the Japanese Association of Surveyors. Users such as surveyors and GIS national programs are now easily available of these real time data, directly or from service providers, through the links of mobile communication network.

GSI is implementing a plan to modify major part of GEONET -constituting GPS reference stations to RTK (Real Time Kinematics) data service specification. The 200 stations have already been modified to the RTK data service specification before May, 2002, and the modification will be extended to 874 stations within fiscal 2003. The series of project is aimed to facilitate the national level re-Mapping and GIS implementation activities based on the new coordinate standard "JGD2000" and to support the "e-Japan" governance program.

(5) ECDIS

Meanwhile, the electronic coastal charts based on the IHO recommendation (WGS84) has been implemented by the responsible authority, Japanese Coast Guard.

c. Navigation activities

In Japan, GPS have already become the most important and essential information technology tool for many navigation systems, fleet management, the related ITS (Intelligent Transportation System) services, and the location based information services combined with mobile phone applications. We can see such aspects in Chapter-4.

2. Augmentation Systems and Services

There are six (6) kinds of augmentation systems in Japan, for aviation, maritime, car navigation, RTK precision surveying and works. Five(5) services excepting MSAS (Multi-functional Transport Satellite based Augmentation System) have already been provided.

a. For Car Navigation

Japanese car navigation industry is already one of the most important of all in current GPS utilization, from the economic view point of the information technology industry. A nationwide DGPS service using FM sub-carrier has been contributing to further growth of car-navigation and location-based-service business, since commencement of its service in May, 1997.

This commercial DGPS service is conducted by private sector entity, "GPex" founded by the voluntary supports of the 17 memberships of Japan GPS Council. GPex operates seven (7) DGPS Reference Stations throughout the country, and DGPS augmented data are broadcast for public, with DARC type FM multiplex formula, known as one of the ITU-R standards, via the FM broadcasting network of the existing 40 transmitting stations all over Japan. The DGPS data are interchangeable with the international standard RTCM SC-104 and NRSC/RBDS format in the U.S.

The service is provided without direct user fees, and many of components are designed to make the services for common use to receive the VICS(*) services as well. VICS services are also using the same DARC type FM sub-carrier. It has influence on production cost reduction of hardware, and on synergy effects in both marketing and improving ecology. An association estimated that approx.1.2 billion liter fuel can be saved by the effect of popularization of car-navigation products and VICS services in year 2010, and it will also reduce a huge amount of CO₂ accordingly.

(*) Vehicle Information and Communication System : traffic jam information and route guidance services, one of the ITS programs

b. Wide area augmentation for Aviation, MSAS (SBAS)

MSAS (MTSAT Satellite-based Augmentation System) represents a GPS augmentation system based on use of geo-stationary satellites. The MTSAT (Multi-functional Transport Satellite) will be deployed at the allocated orbit slot, 140 degree East, with two main Missions for enhanced aeronautical services and for continuous regional meteorological services. The Aeronautical Mission above provides for aeronautical mobile satellite services for voice & data communication & surveillance (ADS), and also GPS augmentation for satellite navigation aid.

The objectives of MSAS is to augment GPS SPS signals sufficiently to support the civil aviation use of GPS, to meet operational requirements for various phases of flight;

- GPS like additional ranging signal for service availability and continuity
- Integrity information
- Differential correction

MSAS ground facilities composed of master control stations (MCS), ground monitor stations (GMS), and monitor and ranging stations (MRS), have already been established. The 1st MTSAT satellite, however, failed its successful launch in 1999. The alternative satellite will be expected to be launched in 2003.

c. Maritime DGPS service for nation-wide coastal area

The entire national fleets of coastal support vessels, coast guard vessels and lifeboats are fitted with

Loran-C receivers. Nonetheless, many of them have already mounted GPS receivers as well, more than 80~90% in the ocean and fishery vessels, and 15~20 % in coastal fishing boats as of 1998. Then, in compliance with the requirement of maritime beacon DGPS network to meet the needs of public safety demand, the Japanese Coast Guard (JCG) continued their implementation efforts, and achieved FOC (Full Operational Capability), at the end of March 1999, of the Radio Beacon DGPS network with 27 DGPS reference stations in totally covering all over the coastal areas of the country.

The DGPS correction data are transmitted via the following radio beacon sites, (some of them having function only for generating DGPS data), and the services are no-encoded and without direct user fees. Consequently, the maritime DGPS services would bring forth remarkable growth of DGPS uses in coastal fishing and pleasure boats as well.

List of DGPS stations

DGPS Station Name	Latitude	Longitude	Frequency	Transmitting Station ID
Kusiro-Saki	42-58 N	144-23 E	288 khz	630
Abasiri	44-00 N	144-18 E	309 khz	631
Soya-Misaki	45-31 N	141-56 E	295 khz	632
Syakotan-Misaki	43-22 N	140-28 E	316 khz	633
Matumae	41-25 N	140-05 E	309 khz	634
Hamada	34-53 N	132-02 E	305 khz	635
Tango	35-44 N	135-05 E	316 khz	636
Hegura Sima	37-51 N	136-55 E	295 khz	637
Sakata	38-57 N	139-50 E	288 khz	638
Siriya-Saki	41-26 N	141-28 E	302 khz	639
Kinkasan	38-17 N	141-35 E	316 khz	640
Inubo-Saki	35-42 N	140-52 E	295 khz	641
Urayasu	35-37 N	139-54 E	321 khz	642
Turugi-Saki	35-08 N	139-41 E	309 khz	643
Hatizyo Sima	33-05 N	139-51 E	302 khz	644
Nagoya	35-02 N	136-51 E	320 khz	645
Daio-Saki	34-16 N	136-54 E	288 khz	646
Muroto-Saki	33-15 N	134-11 E	295 khz	647
E Saki	34-36 N	135-00 E	320.5 khz	648
Ohama	34-05 N	132-59 E	321 khz	649
Seto	33-26 N	132-13 E	320 khz	650
Wakamiya	33-52 N	129-41 E	295 khz	651
Ose-Saki	32-37 N	128-36 E	302 khz	652
Toi-Misaki	31-22 N	131-20 E	309 khz	653
Tokara Nakano Sima	29-49 N	129-55 E	320.5 khz	654
Gesasi	26-36 N	128-09 E	288 khz	655
Miyako Sima	24-44 N	125-26 E	316 khz	656

d. RTK-GPS Precision Positioning Services

RTK-GPS has become today popular in several surveying applications for real time precise measurements in surveying, construction and machine control applications etc. Two of organization have already been established to provide GPS observation data for RTK (Real Time Kinematics) positioning applications.

Currently, VRN-RTK application is deemed as a new augmentation technology by virtual reference station network (VRN). In Japan, GSI and surveying industry conducted VRN-RTK realization experiments jointly, and attained a success.

(1) RTK-GPS service for land survey using MCA radio channel:

One is the services by "RTK-GPS Experiment Promotion Association" for encouraging effective use of RTK-GPS technology to users of the general construction, general surveying and increasing RTK-GPS applications. This organization has been established in July, 1997 by co-partnership of the Japanese Association of Surveyors with the National Mobile Radio Centers Council that operates MCA (Multi Channel Access) radio communication system. The Association now provides for kinds of demand with transmission service of every one second carrier phase data from the specifically arranged 22 GPS-based Control Stations, through MCA mobile radio channel with both 800MHz analog and 1.5GHz digital.

It is programmed for effective use of the existing MCA mobile radio network conducted by Council above and the nationwide GEONET conducted by GSI (Geographical Survey Institute). It is also expected to achieve increasing productivity and economical effectiveness, and consequently to expand various kinds of applications to meet local and regional needs for precise positioning.

(2) DGPS and RTK-GPS Service for Marine-Construction:

The other is a dedicated service for facilitating "Offshore RTK and DGPS utilization" in the offshore construction and civil engineering works. This organization has been established as a closed promotion body by marine construction group composed of 36 memberships. They have the RTK Reference Service Stations in six major bay areas, and provide their membership companies with pay services of both DGPS and RTK-GPS using a specifically allocated 400MHz spectrum.

(3) VRN technology:

This year, two private sector service providers have been established based on the Virtual Reference System Network (VRN) technology. These service providers make use of the real time data service of GEONET.

Thus, Japan has been realized effective use of DGPS and RTK-GPS for increasing productivity and efficient works of general and offshore construction.

d. Outline of Differential GPS and RTK Services

<u>Ref Station</u>	<u>Operator</u>	<u>Distribution</u>	<u>Charges</u>	<u>Users</u>
27 stations	Japan coast Guard	Maritime radio beacon	Free	coastal public safety
Beppu City	Fishermen's Union	Marine Phone	-----	Under experiment ----
7 stations	Private sector GPex	FM sub-carrier	Free	Car-Navi & consumer use
Kawasaki City	A Private sector	Cellular phone	Pay service	Fleet management for boats
MSAS	JCAB	MTSAT satellite	Free	--- Under construction ---

6 counties	A RTK-GPS Promotion Body	MCA and D-MCA Mobile Radio Channel	H/W rental fee	Land Surveyors
Main ports & Coastal area	A Promotion body	A dedicated channel 400MHz band	Pay service	Marine constructions
GEONET	Private sectors	Mobile phone links	Pay service	surveying, GIS etc

3. Development Activities by governmental agencies and related industries

a. Facilitating GPS uses for Survey, Geodesy, and GIS

- (1) As stated above, GEONET conducted by GSI continues to grow, and many of GEONET sites have been implemented modification programs available to extend RTK-GPS and VRN real time data services to other communication media such as mobile phone links. Following a successful experiment using VRN (Virtual Reference Stations Network) technology during 2000~ 2001, the server service center that control GPS data service in various manners has been established and commenced VRN data services in May, 2002. The GEONET sites to be modified will be expanded up to 894 stations within fiscal 2003.
- (2) Educational programs for switching of the conventional triangular net survey system to the GPS-based survey system based on the long-term program by the government (GSI and MLiT : Ministry of Land, Infrastructure and Transport).
- (3) Standardization activities for GIS format : Co-operative by all of Ministries and Agencies with the leadership of MLiT

b. Automated and Remote controlled construction works

Activities to develop remote controlled operation systems for construction machinery are vital for the field applications at a dangerous zone such as volcano areas. These systems are usually combined with RTK-GPS positioning, CCTV graphical data network, and computer aided CAD system. A new market is emerging for construction machinery mounted with GPS receivers and antennas.

c. Precision farming

It is still functioning that a long term R&D activities for precision farming by the authorities of Agricultural R&D Institute, Universities and the related industry. Related farming machinery manufacturers are marketing their products mounted with the dual frequency GPS positioning system.

d. Maritime and water front control

Hydrographic surveying and river control administration : Japanese Coast Guard and MLiT.

e. Aviation use

LAAS program within GBAS (Ground Based Augmentation System) was offered by JCAB to develop and evaluate Airport Pseudolite Services in 1998, and evaluation test of experimental system was implemented in

2001. Assessment of these achievements and study on the reflection to future policy will become priority subjects in fiscal 2002.

f. Space use

R&D and experimental activities for the improvement of the launch vehicle control, satellite autonomous control on orbit, and precision rendezvous technique in space, using GPS have been implemented by the NASDA (National Space Development Agency) and the space industry.

g. Precision Meteorology

The joint R&D activities for precision meteorology with GPS by and among JMA (Japan Meteorological Agency), GSI, universities and research institutes are important for Japan. The data from GEONET continues to contribute these R&D activities as well. Precise meteorological data will become available shortly for business applications. Local weather forecast such as thunder observation network service is emerging.

**h. A Plan for Regional Navigation and Information Satellite System
(Quazi-Zennithal Satellite Conception)**

NASDA and CRL have been developing basic technologies for satellite-based positioning, including the satellite-mounted atomic clock, the constellation time transmission control, and the high-precision orbit determination. Recently, debates on possible implementation and operation of quasi-zenithal positioning and communication satellite for regional augmentation of GPS system, and developmental conception have come to take place in Japan, as the civil use of GPS progresses rapidly. Especially, these debates are getting heated centered on the political, administrative and space industry circles, subsequent to the Volpe Report on the GPS Vulnerability Assessment (October, 2001) and the political decision on the promotion of Galileo project in EU (March, 2002), and the formation of a cooperative group for realization of the quasizenithal satellite conception has been progressing.

4. Industrial Aspects

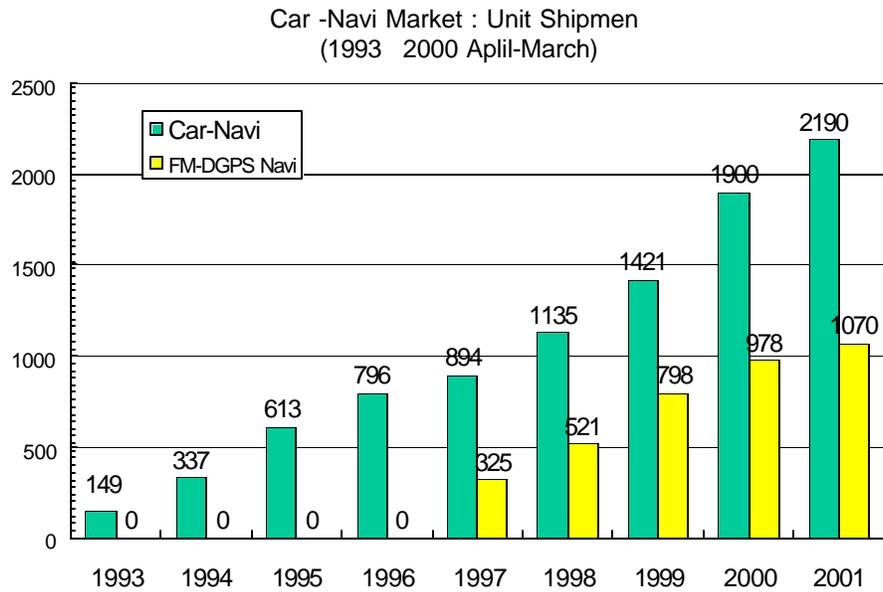
a. Car Navigation

(1) Market growth:

The car navigation markets in Japan continue to grow. The markets have been growing year after year, since the first GPS-based car navigation product was placed on the market in 1991. The sales volume recorded close to 2 million units in the year 2000. Especially, DVD display has gained popularity, and is driving the expansion of the car navigation markets through creation of new demands over the replacement. In fiscal 2001, new car navigation products with HDD (Hard Disc Drive) were widely accepted, and reached 2.19 million units, or 15% increase from the performance in the preceding year.

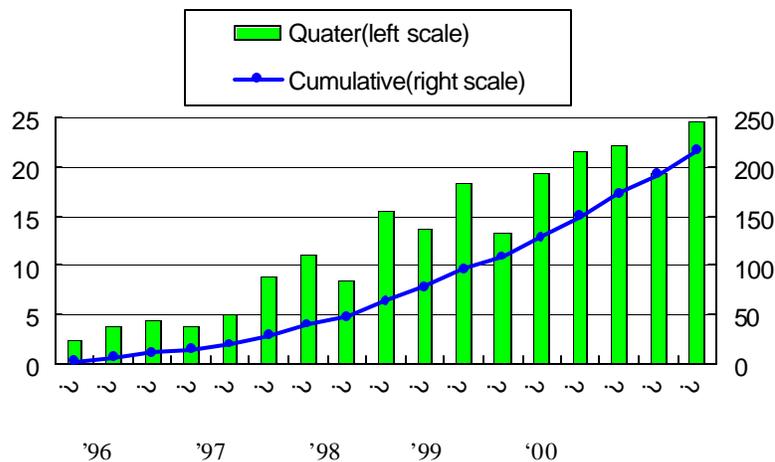
Furthermore, FM-DGPS loading ratio has shown a steady growth even after the turn-off of SA. The car navigation seems to be the fountain of synergistic effects, as represented by sophisticated products for new and trendy "car-multimedia" which combines DVD or HDD display, mobile communications, traffic control

information and other attractive contents.



As seen in the foregoing graph, new mobile-multimedia markets consisting of "Location + DVD/HDD Theater + Telematics" are emerging rapidly in Japan, as the result of combined car navigation with VICS services. VICS (Vehicle Information and Communication System), one of the important elements of ITS in Japan, is a public service, which transmits traffic congestion information and route guidance to the car navigation display via three media, i.e., multiplexed FM, wireless and optical beacon links. VICS Center of service provider is expanding the service area in anticipation of enhanced demands in local cities.

ITS/ VICS Market : Unit Shipments



VICS Center (VICS : Vehicle Information & Communication Service)

The above chart shows the figure as of the 1st quarter of 2001. Total of the shipment record in fiscal 2000 was 989,000 units (Cumulative 2.08 million), and remarkably increased in the last fiscal 2001 to 1.684,000 units (Cumulative 3.76 million)..

b. Emergency call service “HELPNET”

The Emergency-Call service similar to the US's E-911, named "HELNET" (Help systems for Emergency Life saving and Public safety Network) has been launched in the mid-2000. The service provider, Japan Mayday Service Co Ltd was established, after a year long study conducted by Police and Ambulance Agencies, as a private sector entity with investment from the 38 major companies, including car manufacturers, electronics, mobile phone carriers, insurance, banks and security guard fields.

The business of the company is to provide subscribers (mainly car drivers) with emergency information service by connecting to an adjacent police or ambulance office. The service is provided with GPS/DGPS based accurate location data using cellular or PHS mobile phone in car.

c. Great Impact of SA turned off continues

New GPS-related business launching are reported in newspapers almost every day since May, 2000. The driving force is the improved GPS positioning accuracy and stability of signals without SA and the expansion of wireless mobile phone markets.

<Rapid expansion of new business>

- (1) ASP for car navigation and man navigation
 - Traffic hazard forecast (frozen road / weather & traffic / hazard map etc.)
 - Thunder observation network service
 - Kinds of service for search of roaming aged person, stolen vehicles
- (2) Fleet management
 - Bus fleet management services (on-demand bus / efficient shuttle bus etc.)
 - New services by taxi (tour guide, shopping guide, transportation to/from day-care center, etc)
 - Waste collection vehicles monitoring (chemicals / industrial waste / solid waste, TVs etc.)
 - Construction machine leasing network with GPS telematics
- (3) Telematics services for car navigation and mobile phone users
- (4) Robotic construction (full-automatic crawler drill / IT hydraulic excavator etc.)
- (5) Handheld positioning and navigation
 - The 3G-model mobile phone ("au"™) with incorporated GPS capability, put on the market at the end of 2001 by KDDI, one of the mobile phone service providers in Japan, has gained a wide acceptance, and the number of subscribers has exceeded 1.4 million already.
 - The security service providers who utilize "au"™ are also gaining subscribers rapidly.
 - The abovementioned "HELNET" is expanding the target customers to the "au"™ subscribers in addition to the car navigation users.
- (6) Others : Many entrepreneur are emerging.

5. National Policy activities and decisions

As in other countries, the responsibility for basic policy, installation, operation and maintenance of navigation and positioning systems is delegated to the related Ministries and Agencies In Japan. In compliance with necessity of coordination between Ministries for GNSS issues, Japan has set up the "Ministerial Interface Committee for civil uses of Satellite based Positioning System" At the beginning, the Interface Committee was

made up of seven (7) Ministries, but the number has been increased thirteen (13) Ministries and Agencies (*), and is well functioning since its establishment at the end of 1996, working out the ways to expand and facilitate the civil use of GPS in Japan, and in policy recommendations for bilateral consultations in the international community.

Japan GPS Council have been playing an important role in assisting Japanese policy makers in the relevant fields. We have been and will be expected to be one of the valuable information resources.

(*) The Committee members should be read as follows, due to the re-shuffle in early 2001.

MPM, MLiT, METI, NPA, MOFA, ESTA, JCG, GSI, JMA, MOJ, FDMA, JFA,
and JDA (observer)

MPM : Ministry of Public Management, Home Affairs, Posts and Telecommunications
(including former MPT and MHA)

MLiT : Ministry of Land, Infrastructure and Transport
(including former MOT, MOC and NLA)

METI : Ministry of Economy, Trade and Industry (former MITI)

NPA : National Police Agency, National Public Safety Commission

MOFA: Ministry of Foreign Affairs

ESTA : Ministry of Education, Culture, Sports, Science and Technology
(including former STA)

JCG : Japan Coast Guard, MLiT

GSI : Geographic Survey Institute, MLiT

JMA : Japan Meteorological Agency, MLiT

MOJ : Ministry of Justice

FDMA: Fire and Disaster Management Agency, MPM

JFA : Japan Fishery Agency

JDA : Japan Defense Agency

6. National Responsible Authorities

<u>Use</u>	<u>Responsible Authority</u>
‡ National Coordination	The Ministerial Interface Committee
‡ Land and GIS	MLiT including GSI
‡ Maritime and Water front	MLiT including JCG, and JFA
‡ Aviation	JCAB, MLiT
‡ Space	ESTA including NASDA
‡ Military	JDA
‡ Time / frequency	MPM including Communication Research Laboratory (CRL)
‡ Survey and Geodesy	GSI, MLiT
‡ Industrial affairs	METI and MPM

7. Relevant Conferences / Seminars / Exhibitions to be held:

The following major conferences are scheduled and planned;

- Japan ION-GPS '2002 : 11-13 November, 2002, in Tokyo
- The 9th GNSS-Asia Workshop '2002 : 6-8 November, 2002, in Muhan, China,
- The United Nation : July, 2003, in Okinawa
- The joint co-operative event with CGSIC/IISC Tokyo Meeting, Japan ION-GPS '2003 and the 10th GNSS-Asia Workshop '2003 : 11-14 November, in Tokyo or Kyoto

8. National Point of Contact : For Civil Association

Mr Hiroshi Nishiguchi

Secretary General of Japan GPS Council (JGPSC)

Vice-Chair of the CGSIC/IISC Asian Region

Address : Tojo Bldg. 8F, 3-16-10 Yushima, Bunkyo-Ku, Tokyo 113, Japan

Telephone: +81-3-3839-6844 Fax: +81-3-3839-2166

E-Mail : jgpsc@da2.so-net.ne.jp

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