2-7 Global Mutual Recognition Arrangement and International Traceability

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In this paper, we explain Global Mutual Recognition Arrangement, the traceability of international standards and our work on these topics in National Institute of Information and Communications Technology (NICT).

Keywords
National metrology standard, Global MRA, Traceability, Calibration

1 Introduction

In recent years, the number of companies that are acquiring ISO9000 series certification is increasing in order to improve quality assurance and customer satisfaction. This is considered to be due to the increasing number of cases that require the acquisition of the ISO9000 series certification as a prerequisite to conduct new business with companies overseas and the standardization of quality management procedures.

According to the ISO9001 which prescribes the requirements of quality management systems under the ISO9000 series, equipment is required to be calibrated in the following manner in order to assure the appropriateness of measurement values for the management of monitoring equipment and measuring equipment[1].

> Calibration, verification or both must be conducted according to measurement standards traceable to the international or national measurement standards during the prescribed interval or prior to use.

On the other hand, ISO/IEC 17025 is the international standard for the calibration capability of laboratories and calibration institutions. It is important that the National Metrology Institute (NMI) acquires ISO/IEC 17025 in order to conduct traceable calibration to the international or national measurement standards. By doing this, calibration conducted at laboratories that have acquired ISO/IEC 17025 (including private sector companies) will be guaranteed to be traceable to the national measurement standards in the form of the international standards.

In addition, in response to the request for enabling calibration certificates issued nationally to be internationally recognized, an agreement relating to the "Global Mutual Recognition Arrangement (Global MRA)" was executed at the 21st General Conference on Weights and Measures in 1999. Consequently, since calibration certificates issued by institutions that participate in Global MRA will be internationally recognized, companies that undergo calibration will not be required to acquire calibration certificates overseas.

National Institute of Information and Communications Technology (NICT) has participated in Global MRA as an NMI from its commencement and acquired ISO/IEC 17025 certification in 2003[2].

In this paper we will describe the outline of the international traceability system for time frequency and Global MRA and introduce the content of NICT activities.

2 The international traceability system

In order to ensure the international traceability of measurement standards, it is necessary to perform an international key comparison of national standards and register on the database managed by the International Bureau of Weights and Measures (BIPM). The guidelines for key comparisons of time and frequency standards have been put together as CCTF-K001.UTC. In other words, the international traceability of time and frequency standards is guaranteed by complying with CCTF-K001.UTC. Each NMI is required to satisfy the following conditions under CCTF-K001.UTC[3]. It must:

1. belong to a Member State of the BIPM or to an Associate of the General Conference of Weights and Measures (CGPM);
2. be equipped with atomic standards;
3. operate equipment adapted for time transfer, producing data in a standard format as requested by the Consultative Committee for Time and Frequency (CCTF) and the BIPM;
4. have the capacity to report data to the BIPM on a continuous basis.

An international time transfer network for time and frequency shown in Fig. 1 has been established and time transfer measurements are periodically conducted between NMIs around the world. The results of these time transfer and the time data provided by each NMI are collected by the BIPM and issued every month as Circular T. Consequently, participation in this time transfer network is a condition of guaranteeing international traceability. In addition, the International Laboratory Accreditation Cooperation (ILAC) creates guidelines for the application of the conditions for laboratories (ISO/IEC 17025) and the conditions for laboratory accreditation institutions (ISO/IEC 17011) and harmonizes the work content of accredita-

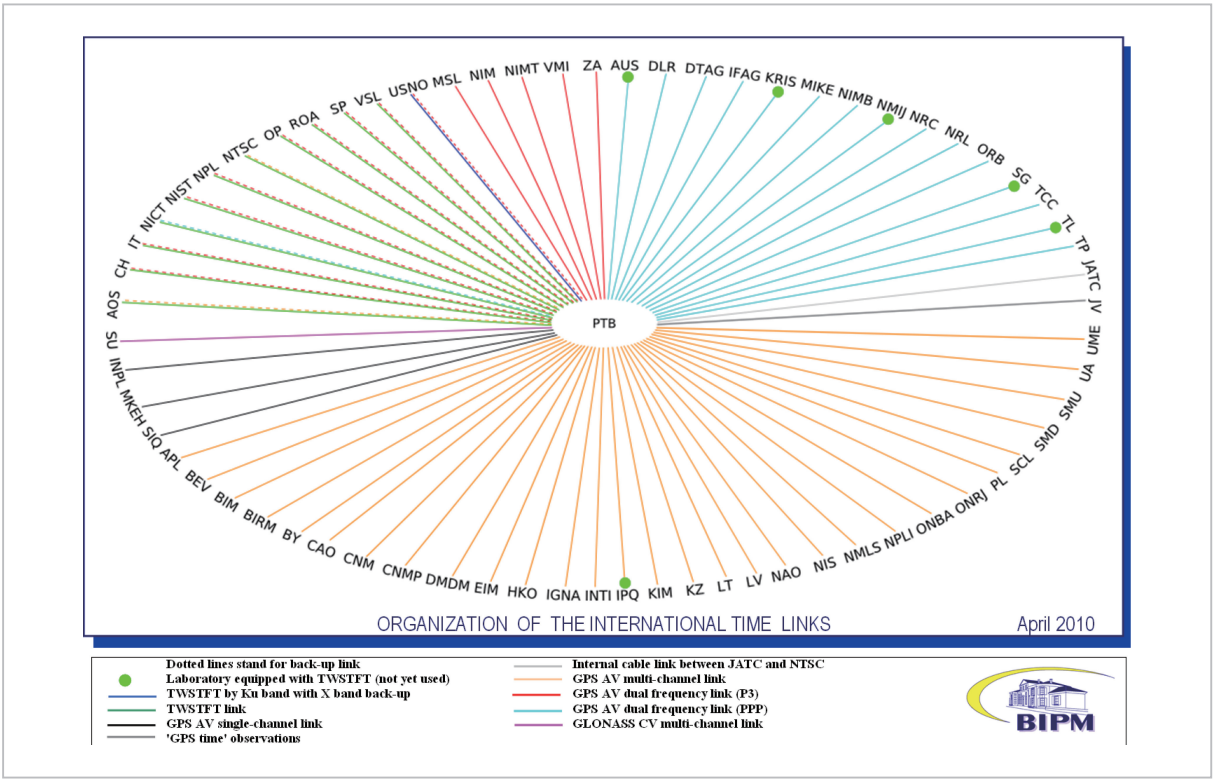

Fig.1 *Organization of the international time links*[4]

tion institutions.

The International Accreditation Japan (IAJapan), responsible for conformity accreditation of the National Institute of Technology and Evaluation (NITE) in regard to the traceability of measurement standards in Japan, and the Japan Accreditation Board for Conformity Assessment (JAB) provide accreditation for conformity assessment institutions such as laboratories and calibration institutions based on ISO/IEC 17025, etc. Among these, the accreditation in the time and frequency field is conducted by IAJapan.

The Japan Calibration Service System (JCSS) is subject to the ISO/IEC 17025 (calibration institution), one of the accreditation programs operated by IAJapan. This is a voluntary system that assesses whether the requirements for the standards regarding calibration institutions (ISO/IEC 17025) prescribed by the International Organization for Standardization and the International Electrotechnical Commission are being satisfied and registers calibration operators. When registered calibration operators conduct calibration in the relevant registered measuring equipment category, the calibration operator can send a calibration certificate with the JCSS logo attached. In other words, calibration certificates with the JCSS logo or JCSS accreditation symbol ensures the traceability of the national measurement standards in Japan and shows the technical capability of the relevant calibration operator. Furthermore, if calibration operators meet the necessary requirements, the relevant operator can receive the accreditation compliant with the international Global MRA, and in such cases, issue calibration certificates with the registered ILAC-MRA accreditation symbol. Calibration results of calibration institutions that have received the International MRA accreditation are handled by equivalent calibration certificates used between mutual recognition signatory institutions.

Conversely, calibration certificates with logos issued by NMIs or other specified calibration institutions are referred to as jcss (“small jcss”) certificates. jcss certificates show that

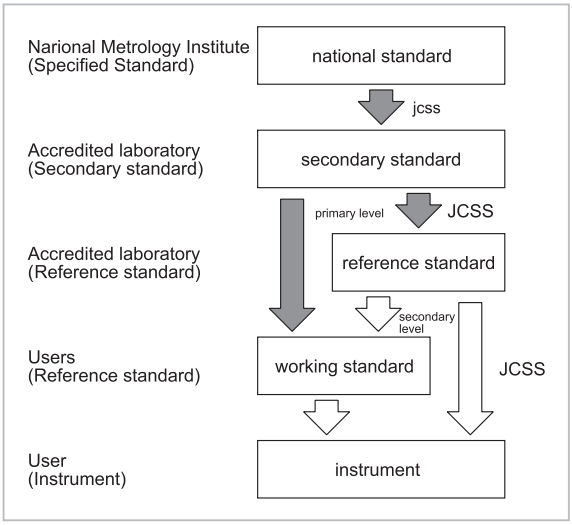

Fig.2 *Hierarchical scheme for JCSS traceability*

calibration has been conducted using national standards, and since jcss accreditation is not compliant with the international MRA, it is only effective for calibration operators in Japan. However, traceability up to jcss accreditation is necessary in order to receive JCSS accreditation since jcss accreditation is the basis of traceability of the national standards in Japan. The JCSS traceability stages are shown in Fig. 2.

On the other hand, the accreditation of calibration operators that does not comply with JCSS is covered by the Accreditation System of National Institute of Technology and Evaluation (ASNITE) operated by also IAJapan. For example, when there are no other methods to use the traceability to the national standards of other countries due to the lack of the relevant national standards in Japan or the calibration operator is a foreign operator or Global MRA applies between the NMIs, ASNITE accreditation can be received. NMI may issue internationally recognized calibration certificates that comply with ISO/IEC 17025 by receiving ASNITE that complies with Global MRA.

3 Global MRA

Even if traceability between each NMI and the international standards is guaranteed by the International Traceability System, the uncer-

tainty of measurements by NMIs needs to be separately determined since it is possible that time transfer accuracy and the stability of atomic clocks, etc., may be different between the NMIs. However, Global MRA has a framework to address this.

Global MRA has an Appendix from A to E and an outline of each is provided below.

Appendix A : List of NMIs that are signatories to the MRA, together with their logos
Appendix B : Results of key comparisons carried out by the Consultative Committees (CCs), the BIPM or the Regional Metrology Organization (RMO) and results of supplementary comparisons carried out by the RMOs to support confidence in calibration and measurement certificates
Appendix C : List of Calibration and Measurement Capabilities (CMC) of NMIs
Appendix D : List of key comparisons
Appendix E : Terms of reference of the Joint Committee of the RMOs and BIPM (JCRB)

Among these, Appendix B contains the CCTF-K001.UTC guidelines for the key comparisons of time and frequency standards.

Conversely, the calibration amount, measurement scope and uncertainty, etc., for each NMI are specified in the CMCs recorded in Appendix C. This guarantees the calibration capability amount and the measurement uncertainty of NMIs in accordance with the International Traceability System. Since CMC is an important document that guarantees uncertainty of calibrations, it is necessary for each RMO to be assessed by another RMO after the relevant RMO has conducted an internal assessment.

Each RMO prescribes independent internal assessment procedures. For example, the Asia Pacific Metrology Programme (APMP) complies with the following procedures referred to as APMP-G1.

1. Quality System (QS) certification
2. Submission of CMC and QS information to the Technical Committee (TC) Chair
3. Review by TC
4. Approval by the Chair of the Technical Committee on Quality System (TCQS)
5. Submission to the JCRB website and reviews between RMOs are conducted according to the flowchart shown in Fig. 3.

4 NICT activities

As the Chair of the APMP Technical Committee for Time and Frequency (TCTF) since 2008, NICT arranges and collects CMC reviews, and from this time, 2 CMC cases have been registered on the JCRB database. There are a total of 7 NMIs contained in these CMCs. Furthermore, in fiscal 2010, APMP conducted an internal review of the 2 CMCs and is scheduled to register the inter-RMO reviews within the fiscal year. The CMCs arranged by NICT as the Chair are shown in Table 1.

In addition, NICT is arranging 5 CMC reviews conducted by the APMP TCTF in 2009 regarding inter-RMO, and conducting the registration of the review results and CMC approval, etc.

In regard to calibration, NICT received an ISO/IEC 17025 certificate in 2001 after receiving ASNITE and jcss accreditation in 2003 and issued calibration certificates. The Space-Time Standards Laboratory is currently conducting calibration of frequency standard equipment that outputs 1 MHz, 5 MHz or 10 MHz sinusoidal wave signals for ASNITE calibration and 5 MHz or 10 MHz sinusoidal wave signals as jcss calibration, and is determining the uncertainty and creating manuals, etc., in the aim of expanding the scope of calibration frequencies and conducting time scale calibrations. Please see the reference below for more details regarding frequency calibration[6].

5 Conclusion

Due to the International traceability infrastructure and Global MRA, once calibration is performed, it can be received anywhere around the world (One Stop Testing). With the progress of globalization, the importance of this system is increasing from an efficiency view-

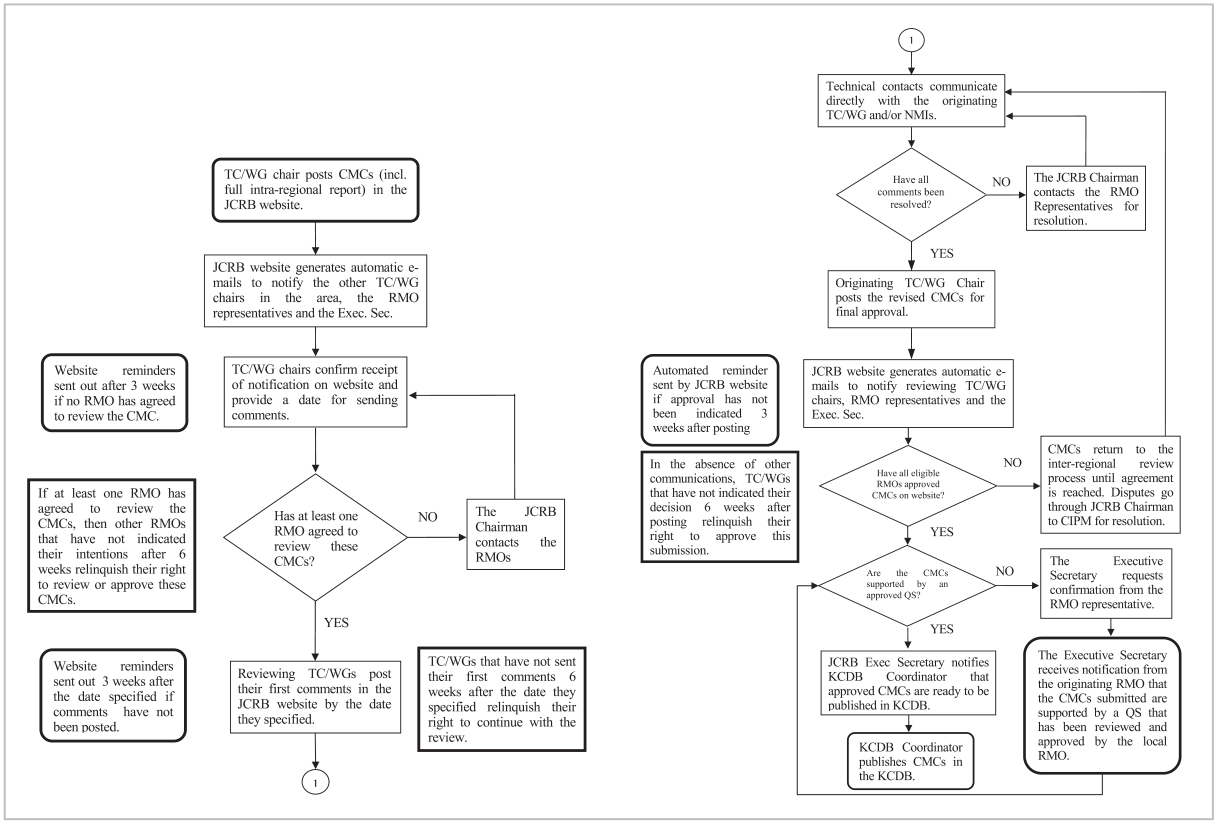

Fig.3 *Flowchart of inter-RMO reviews*[5]

Table 1 *CMCs arranged and collected by NICT*

CMC	NMI	
APMP.TF.7.2008	KRISS, NICT, NIM, NIMT, NMIJ, TL	Registered in the JCRB database
APMP.TF.8.2010	VMI	Registered in the JCRB database
APMP.TF.9.2010	NPLI	Submitted to inter-RMO reviews
APMP.TF.10.2010	A*STAR	Submitted to inter-RMO reviews

point. In order to appropriately conduct calibration, it is necessary to maintain and manage measurement systems and national standards, and periodically perform internal audits and management reviews, etc., based on ISO/IEC 17025. NICT is scheduled to conduct the required work and research and development which meet the needs of domestic and overseas operators by operating national standards in a stable manner, improving calibration uncertainties and greatly expanding the calibration menu.

In addition, through the review and collection of CMC, NICT aims to make further contributions internationally. In particular, there are numerous institutions in the Asia-Pacific region that are planning to create national time and frequency standards, receive CMC registration in the JCRB database and participate in Global MRA. NICT plans to formulate guidelines regarding methods for calculating uncertainties and conduct activities that reduce the burden on institutions creating calibration systems and performing CMC reviews.

A Abbreviations

[APMP]: Asia Pacific Metrology Programme
[ASNITE]: Accreditation System of National Institute of Technology and Evaluation
[CCTF]: Consultative Committee for Time and Frequency
[CMC]: Calibration and Measurement Capabilities
[Global MRA]: Global Mutual Recognition Arrangement
[ILAC]: International Laboratory Accreditation Cooperation
[JCRB]: Joint Committee of the RMO and BIPM
[JCSS]: Japan Calibration Service System
[NITE]: National Institute of Technology and Evaluation
[NMI]: National Metrology Institute
[QS]: Quality System
[RMO]: Regional Metrology Organization
[TCQS]: Technical Committee of Quality System
[TCTF]: Technical Committee of Time and Frequency

B Vocabulary

The following are excerpted from "International vocabulary of basic and general terms in metrology [7]".

Metrological Traceability
Property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

Calibration
Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

International measurement standard
Measurement standard recognized by signatories to an international agreement and intended to serve worldwide

National measurement standard
National standard measurement standard recognized by national authority to serve in a state or economy as the basis for assigning quantity values to other measurement standards for the kind of quantity concerned

Primary measurement standard
Primary standard measurement standard established using a primary reference measurement procedure, or created as an artifact, chosen by convention

Secondary measurement standard
Secondary standard measurement standard established through calibration with respect to a primary measurement standard for a quantity of the same kind

Reference measurement standard
Reference standard measurement standard designated for the calibration of other measurement standards for quantities of a given kind in a given organization or at a given location

Working measurement standard
Working standard measurement standard that is used routinely to calibrate or verify measuring instruments or measuring systems

References

1 ISO 9001:2008 “Quality management systems — Requirements,” International Organization for Standardization, 2008.

2 T. Iwama, N. Kurihara, M. Imae, M. Hosokawa, and T. Morikawa, “Global Mutual Recognition Arrangement (Global MRA) and Traceability,” Journal of the National Institute of Information and Communications Technology, Vol. 50, Nos. 1/2, pp. 187–193, 2003.

3 Guidelines for participation in the ongoing key comparison in time CCTF-K001.UTC.

4 BIPM Annual Report on Time Activities Vol. 4, 2009.
http://www.bipm.org/utils/common/documents/tar2009/Time_annual_report_2009.pdf

5 Calibration and Measurement Capabilities in the context of the CIPM MRA (CIPM MRA-D-04 Version 1), Oct. 2008.
http://www.bipm.org/utils/common/CIPM_MRA/CIPM_MRA-D-04.pdf

6 H. Saito, T. Iwama, S. Tsuchiya, and Y. Koyama. “Frequency Calibration,” Special issue of this NICT Journal, 2-5, 2010.

7 International vocabulary of metrology - Basic and general concepts and associated terms (VIM), JCGM, 2008.

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Atomic Frequency Standards, Space-Time Measurements