COMMISSION 31 TIME-TEMPS

Minutes of the Business Sessions held at the XXII IAU General Assembly in The Hague

First Session: sub Session (1) of 18 August 1994

Chairman : E. Proverbio

The session was dedicated to the proposal of new Members, new Consults and, Members. The following list has been unanimously approved :

New members :

Lee A. Breakiron	(Naval Observatory, USA)
Veronique Dehant	(Observatoire Royal de Belgique, Belgique)
K. Dorenwendt	(PTB, Germany)
Wu Guichen	(Shaanxi Astronomical Observatory, China)

New consultant members :

Baumont F.	(CERGA, France)
Busca G.	(Observatoire de Neuchatel, Switzerland)
De Marchi A.	(IEN, Italia)
Koshelyaesky N.	(VNIIFTRI, Russia)
Kouba J.	(Geological Survey, Canada)
Pialat G.	(CSIR, South Africa)
Quinn T.J.	(BIPM, France)
Sinenko L.A.	(NPO VNIIFTRI, Russia)
Tavella P.	(IEN, Italia)
Audoin C.	(Université Paris Sud, France)

The following proposals for President and Members of OC (1994-97) were unanimously approved :

President : H. Fliegel

Members of Organizing Committee : D. Allan, D. Backker*, G. Beutler*, V.H. Brumberg, M. Fujimoto, M. Granveaud, W. Klepczynsky, J. Luck, E. Proverbio (ex officio), Qi Guan Rong*, C. Thomas*, G. Winkler*, Ch. Veillet* (* new Member).

John Luck informed the President that he could not accept to become Vice-President for the period 1994-1997; the election for this position has been postponed to the next business meeting to be held on August 23.

The chairman proposes and Commission approved the following IAU representatives:

BIPM/CCDS : Gernot M.R. Winkler
FAGS : Paul Pâquet
CCDS WG : "Application of General Relativity to Metrology", T. Fukushima

Finally the Members of the Commission approved the proposal to maintain the two working Groups, with the respective new Chairman :

I. Appenzeller (ed.), Transactions of the International Astronomical Union Volume XXIIB, 193-199.

WG : "Use of millisecond pulsars and timing of pulsars", Chairman : G. Petit

WG : "Time transfer with modern techniques", Chairman : D. Allan

First Session : sub Session (2) of 18 August 1994

Chairman : G. Petit

Five reports were presented by Members of the Commission 31 about activities related to Time; the corresponding meetings were held in various Institutions and Committees. In addition, the two Working Groups installed by Commission 31, "The use of millisecond pulsars and timing of pulsars" chaired by D. Allan, and "Time Transfer with modern techniques" chaired by J. Luck, maintained their activity, although no report could be formally presented during the Session.

(1) Report of the Comité Consultatif pour la Definition de la Seconde (CCDS), by G.M.R. Winkler, IAU representative to the CCDS

Dr. Winkler presented a written report of the CCDS activities concerning the following topics :

(i) progress in atomic frequency standard and clock ;

(ii) International Radio Consultative Committee : Recommendation 538-2 on Frequency and Time instability measures and Recommendation 767 on the use of GPS and GLONASS for high-accuracy Time transfer;

(iii) synchronisation of clocks using satellites;

(iv) pulsar-time;

(v) Recommendations of the CCDS submitted to the CIPM (6 recommendations).

A meeting of the CCDS advisory group on TAI will be held in March 1995 at the Bureau International des Poids et Mesures in Sèvres.

In view of the coming meeting the following items were discussed :

- *Needs to review the priorities regarding TAI dissemination.*

Two approaches are considered. A fast publication of the TAI values within a short time delay following the data transmission to BIPM of the observations performed by participating laboratories; later the final values would be published in the BIPM Annual Report. A second option is a mid-term one by making available the final values of TAI in a time internal of 30 to 50 days. Presently and in a operational point of view the second one is probably the best choice.

A daily transmission to BIPM of the observation performed by participating laboratories to TAI is also considered. It will conduct to make TAI available in a quasi real time and in principle, would allow to detect rapidly systematic clock effects.

- *Removal of systematic deviations in input data.*
Presently BIPM applies weights which are supposed to handle the role of systematic deviation by down weighting clocks that have suffered a disturbance. However, the weights, even reduced, mean that these systematics make larger contributions than they should. Any procedures based on statistics require the absence of changing trends. The present procedure is therefore, not statistically sound.

- *Weight limits.*
The limits should be reviewed in the light of the new HP5071 clocks. A dilemma seems to appear : or no limits should be adopted or an upper limit has to be applied. Some limits are probably necessary; the best compromise has to be studied.

- *Absolute rate accuracy.*
Up to now, a unique reliance exists with the PTB standards. This is dangerous. The situation must be reviewed according previous CCDS recommendations. On the other hand, the HP5071 could make a contribution if the data are produced with certain cautions.

- *Non-Cs contributors.*
There is a problem in accepting H-masers which may be correlated with each other. There is a problem in accepting sporadic data from other devices which may be potentially valuable.

- *Input links and access questions.*
There are now much more data available that are derived from two-way satellite links. This data input has to be reviewed.

- *Assistance from contributing laboratories to BIPM.*
BIPM's role requires it to be a final arbitrator and coordinator. If future proposals to generate TAI are rising more work than can be handled by BIPM why not ask the contributors to make some pre-analysis, or be helpful in some other way to be explored. It is very unlikely that the support for BIPM can be increased by governments, therefore, there must be a judicious selection of what work must be done by BIPM and what could be eventually delegated. This should be explore in the light of the great range of support available in the various laboratories.

(2) Report of the CCDS Working Group on the Application of General Relativity to Metrology, by B. Guinot, Chairman of the Working Group

The definition of the units of the International System (SI) does not mention the theoretical framework in which they must be understood (with the exception of the kelvin). It is usually admitted that they are implemented according to the laws of classical physics.

But the accuracy of time standards and the definition of the metre require a clarification of the relativistic meaning of the SI definition. Einstein's theory of General Relativity has passed successfully all experimented tests and provides a convenient theoretical background for metrology. However, we still have to describe this theory in metrological terms.

In order to fulfil this task, the Comité International de Poids et Mesures decided in 1992 to create a working group on the Application of General Relativity to Metrology and placed this group under the authority of the CCDS. The mandate of the group is, in brief, (a) to provide a report on the interpretation and implementation of SI definitions on General Relativity at an accuracy level compatible with the existing standards, (b) to study the consequences of the expected improvement of time standards.

Only task (a) is being developed. The key of the metrological aspect of General Relativity lies in Einstein's Equivalence Principle, which states the universality (in time and space) of the laws of physics in local experiments, when using local standards. A more delicate problem is that of the metrological meaning of space-time coordinates, which are in principle non-measurable quantities. However, these coordinates are already widely used in time (usual time scales), and also in space for astronomy, geodesy, positioning. Their expression in acceptable metrological terms is a real and practical problem. The report will also contain formulae for applications.

The members of the working group are (with indication of the body they represent, if any) : N. Ashby, J. de Boer (CCU/CIPM), C. Boucher (IUGG), V.A. Brumberg, T. Damour, T. Fukushima, B. Guinot (CCDS/BIPM, chairman), W. Israel, G. Petit (BIPM), B.W. Petley (CCM/CIPM), M.H. Soffel, J. Mc A. Steele (URSI), C. Thomas (BIPM, Secretary), C.M. Will, P. Wolf (BIPM). IAU and IUPAP representatives have not yet been designated.

All comments and contributions from other persons will be welcome at the address: B. Guinot, c/o Dr. C. Thomas, BIPM, Pavillon de Breteuil, F-92312 Sèvres Cedex, France (e-mail : internet, bipm@obspm.fr; BITNET, bipm@frmeu51).

3) Report of the BIPM Time section, by G. Petit, Time section

The BIPM Time section has been in charge of the establishment and dissemination of TAI since January 1988. In the period 1991-1994 the main features of this activity have been the following.

- Clock data:
There has been a slight increase in the number of laboratories maintaining a local UTC (lab), and a significant increase (<10%) in the number of clocks data reported. More significantly, this increase is nearly entirely due the introduction of the new highly stable HP5071A clocks. Electronic mail (internet) is now the main means of communication of data.

- Time links:
Nearly all of the links are computed using GPS data recorded by the laboratories, according to the tracking schedules issued by the BIPM. Only 2 to 4 links are computed using LORAN-C data. The two long-distance GPS links between Europe and North America and between Europe and East Asia are computed with precise ephemerides from the International GPS Geodynamics Service (IGS) and with ionospheric measurements.

- Algorithm:
There has been no change in the algorithm ALGOS. More clocks (35% in 1994 vs. 15-20 % in 1991) reach the maximum weight, mainly HP5071A and H-masers. As a consequence the maximum weight represents only 0.8 % of the total, down from 1.6% in 1991.

- Steering:
The steering procedure to ensure the accuracy of TAI still relies mainly on the two primary standards from PTB (CS1 and CS2). The primary standard CRL-CS1 has had two evaluations over the period and LPTF-JPO has had one evaluation. Steering has been done by frequency steps of 5.10-15, a few times until June 1992, then once in 1993. The steering procedure will be reviewed by the CCDS advisory group on TAI.

- Dissemination:
The monthly circular T has been issued regularly, with some cosmetic changes and some additional information introduced. The BIPM Time section has set up an account

reachable by anonymous ftp on mode 145.238.2.2. Circular T, tables of the annual reports and other data are available. The read.me file in the directory (anonymous.tai) provides the necessary information.

4) Report of the Central Bureau of the International Earth Rotation Service on the UTC system, by M. Feissel, Head of the Central Bureau

The series of leap seconds initiated in 1972 by the BIH has been continued by the IERS since 1988. After a period of relative acceleration of the Earth's rotation in the mid 1980's (the longest interval between two leap seconds was 2.5 years), the rotation rate is back to earlier values, leading to an interval of 1 or 1.5 year between leap seconds. It is suggested that the possible ways to provide users with the difference UT1-TAI be again investigated. The UTC compromise was implemented more than 20 years ago; the evolution of techniques and procedures may allow to use a less extreme process than the present I second time steps.

5) Report of UT1 determination at the US National Earth Orientation Service, by D.D. McCarthy, Head, Earth Orientation Department, USNO

The U.S. National Earth Orientation Service (NEOS) is a joint venture of the U.S. Naval Observatory (USNO) and the Geosciences Laboratory (GL), National Oceanic and Atmospheric Administration (NOAA). It serves as the Sub-bureau for Rapid Service and Predictions of the International Earth Rotation Service (IERS). In this capacity it publishes a weekly bulletin containing the observed values of Earth orientation parameters (EOPs) contributed by participants in the IERS, quick-look daily estimates of the EOPs determined by smoothing the observed data, predictions of x, y and UT1-UTC, up to ninety days following the last day of quick-look data, and observed values of the Celestial Pole Offsets dpsi and deps as observed by VLBI. Also included are the combination series for the offsets as well as predictions for up to ninety days. The NEOS Bulletin is distributed by Oh UTC of Friday of each week by mail and electronic mail.

NEOS maintains an anonymous ftp site which contains a number of files including the most recent IERS Bulletin A, the most recent EOP data, long-term predictions of Delta T, the historical difference between International Atomic Time (TAI) and Coordinated Universal Time (UTC), and the tables and subroutines found in the IERS Standards (1992). The EOP data are updated weekly, the Delta T predictions are updated annually, and the TAI-UTC file and the IERS Standards related files are updated whenever changes have occurred. To obtain these data, ftp to maie.usno.navy.mil (192.5.41.22), login as anonymous, give your full e-mail address as the password, change to the appropriate directory, and get the appropriate file. The EOP-related files are kept in a subdirectory called ser7 while the IERS Standards related files are kept in a subdirectory called standards.

NEOS also maintains a Computer Bulletin Board at the U.S. Naval Observatory providing the latest version of the IERS Bulletin A, NEOS VLBI observations of Earth orientation (IRIS and NAVNET), and other data and software of interest to those concerned with precise connection of reference frames. The telephone number for the NEOS Bulletin Board is 202-653-0597.

The algorithm used by NEOS in the determination of the quick-look estimates of the Earth orientation parameters is based on a weighted cubic spline with adjustable smoothing fit to contributed observational data corrected for possible systematic differences. Statistical weighting used in the spline is proportional to the inverse square of the a priori accuracy of the individual techniques, indicated in Table 1

for 1993. The accuracies of the combined results are +/-0.3 msec of arc in x, +/-0.3 msec of arc in y, +/-0.03 msec of time in UT1-UTC, +/-0.3 msec of arc in dpsi, and +/-0.3 msec. of arc in deps.

Table 1 ESTIMATED PRECISIONS OF THE TECHNIQUES.
Units are milliseconds of arc for x, y, dpsi, and deps, and milliseconds of time for UT1-UTC

Contributor	Estimated Precision				
	x	y	UT1	dpsi	deps
LAGEOS 3-day SLR	0.4	0.4	0.07		
Delft 3-day SLR	0.4	0.4			
NEOS daily VLBI			0.03	0.7	0.2
NEOS weekly VLBI	0.3	0.5	0.03		
Texas LLR (Haleakala)			0.24		
Texas LLR (CERGA)			0.25		
Texas LLR (MLRS2)			0.15		
JPL VLBI	baseline dependent				
GPS (IGS combination)	0.2	0.2			

In addition to the predicted values of x, y, UT1-UTC and celestial pole offsets, predicted values of UT1-TAI up to 2015 are available on request. Please contact the Sub-Bureau for Rapid Service and Predictions for details on how to obtain these data.

First Special Business Session of 23 August 1994

Chairman : E. Proverbio

The Chairman proposes as Vice-President of the Commission 31 the following names: T. Fukushima and Jin Wen Jing. The names are put to the vote; Dr. Fukushima has been proposed as Vice-President of Commission 31.

Second Session of 24 August 1994

Chairman : H. Fliegel

An informal discussion on the proposals of the IAU General Secretary concerning the restructuration of the IAU Commissions and WG, is conducted by Dr. Fliegel.

Explaining the recent proposal to combine Commissions 4, 8, 19, 24 & 31, Dr. Fliegel suggests that the division President be nominated from all Commission Members by 15 November.

J. Kovalevsky presented his views on the reorganisation of the Union. He reviewed the history of the opposition to the proposal of merging Commissions into larger bodies. The new proposal by the EC, retaining the role and the list of present Commissions, is much more acceptable and has the advantage of direct contacts with the governing body of the IAU, especially on scientific matter, which did not really exist before. He mentioned also that the new IAU President has considered as very desirable that General Relativity be formally introduced in the Fundamental Astronomy division as a new Commission. He invited J. Kovalevsky to organize such a Commission during the three years to come and have this topic in the agenda of the next General Assembly.

The problem of communication among the different Commissions inside the division has been also discussed. H. Fliegel will issue circular letters to all Members of Commission 31 about every 6 months containing the items received by the Commission President submitted by Members for circulation.

M. Feissel thinks the new structure could be able to secure the upwards circulation of proposals and ideas among the different divisions, inside the division, and with the Executive Committee. In particular, it must be the case for the circulation of the reports of the FAGS Services that are important pieces in the IAU, especially in fundamental astronomy.

During a discussion concerning the WG on Standards, H. Fliegel thought that such a WG could became a Commission. J. Kovalevsky suggested that the service structure would better correspond to the permanent working plan, especially that it should involve also IAG.

M. Feissel expresses her hope that the WG's are the place where the work of IAU is made and gives some basis suggestions to insure that they are really active, e.g.:

(i) nominal 3-year term, with retrieving and reappointment of WG members at every General Assembly;
(ii) nominal 3-year term for the chair person, with an absolute maximum of 6 years;
(iii) the WG's should provide, for the Commission, printed reports at the GA as suggested by Dr. Mc Carthy.

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