INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

WP-7A Special Rapporteur Group
1 March 2004

UTC TRANSITION PLAN

1.0 Background

As a result of issues raised by sector members of the ITU-R (International Telecommunication Union - Radiocommunications) and a letter from the Director of the Bureau International des Poids et Mesures (BIPM) to the Secretary General of the ITU, a new question, ITU-R 236/7 (2000) "The Future of the UTC Timescale", was generated by ITU-R Study Group 7 (Science Services) Working Party 7A (Standard Frequency and Time Signal Services). The question considers the future definition and use of Coordinated Universal Time (UTC) in the ITU-R Recommendations. Any *major change to the UTC timescale* as defined in the current recommendations has a potentially significant impact on synchronization of communications networks, navigation systems and time distribution performance. Due to the potential impact of changing the UTC Time Scale and to focus on the issues, Study Group 7, Working Party 7A established a Special Rapporteur Group (SRG) to specifically address the future of the *leap second and related issues*.

The SRG has established liaison with Section Members and related scientific bodies to address the question. Coordination and technical exchange meetings have been held over the past 4 years to gather data on UTC utilization, analyse usage and examine *alternative approaches to reduce or eliminate the operational impact of the leap second*. Meetings were held in conjunction with International Conferences dealing with Time and Frequency as well as special presentations to the Institute of Navigation and the Civil GPS Interface Committee. Several bodies in the international community conducted surveys and information fact-finding that produce mixed results.

2.0 The Question of the Future of the UTC Time Scale

These efforts had not produced clearly defined user group(s) using UTC time information nor a consensual opinion on future utilization. Consequently, the SRG organized a special colloquium on the future of UTC for deliberating and exploring possible recommendations with representative organizations and contributing parties. At the Colloquium, distinguished representatives in the areas of International Timekeeping, Navigation, Earth Rotation, Telecommunications and Internet Timing were invited to make presentation dealing with the subject areas. These areas would be impacted by changes in the UTC Timescale to one degree or another. Contributed presentations were invited to express additional viewpoints.

The results of the special colloquium were as follows:

1. Analyses of deceleration of the earth's rotation lead to the ultimate prediction of multiple leap seconds per annum to maintain the currently defined tolerance between UT1 and UTC.
2. The astronomical community has great concerns over any change to the current system. These concerns stem from the use of software using UTC as the readily available source of UT1 and this software has been incorporated into instrument pointing systems and other equipment controlling software that has become too old to be readily modified or changed. Similarly, the astrodynamic community concerned with the determination of orbital parameters of artificial satellites and other celestial bodies utilise the UTC for the same purpose.

3. It was generally agreed that at some point the definition of UTC would need to be modified due to changes in the earth's rotation rate. There was no overwhelming consensus on whether the status quo should be maintained until a change was necessary or an alternative should be actively pursued in anticipation of a future change.
4. Advances in telecommunications, navigation and related fields are moving toward the need for a single internationally recognized time scale to regulate and provide uniformity to these systems. The global nature of these systems providing omnipresent precise service are requiring increasingly precise T&F coordination and are becoming integrated international services.
5. Developing telecommunication and navigation systems could produce the need for even more T & F precision systems. Their international service requiring universal synchronization and increased bandwidth. The traditional model of generating internal system time scales for system operation could produce. de facto multiple global time scales. This multiplicity of "pseudo time scales" could lead to confusion and potentially disastrous consequences.
6. The special case of the international computer network, the so-called "Internet", which is facilitated by the international telecommunication network, requires global syntonization. Currently, GPS with it's capability for providing precise T&F for synchronization has been adopted into an ad hoc global plieschronous system. This use in the telecommunication network would be described as a feature of the physical layer. Consequently, intra-system syntonization has not been recognized within the application layers evolving internet protocols.

Several alternative proposals have been put forward concerning the Leap Second and were discussed at the special colloquium. One proposed alternative seemed to be preferred if a change were to be made. The essence of this proposal is:

1. That any change slowly evolve from the current UTC Standard by transition to a uniform timescale, perhaps to be called *Temps International* (TI).
2. A suggested date for inaugurating any change would be 2022, the 50TH anniversary of the UTC timescale. The date suggested is influenced by the lifetimes of existing systems that would be expensive to change.
3. TI should be a continuous atomic time scale, without Leap Seconds, that is synchronized with UTC at the time of transition.
4. Responsibility for disseminating UT1 information should remain solely with the IERS.

2.0 Proposed Transition

The results of the special colloquium and prior activities of the SRG have been considered in the following recommendations.

1. Creation of another time scale, namely **International Time (TI)**, for an evolutionary introduction will add significant complications in the process of defining a new time scale. A name change alone could cause great confusion and complications in the ITU-R process and systems attempting to implement the new standards. Creation of a new name is not recommended. Of the defined time scales typically given in the literature, in fact only UTC is maintained and distributed for international timekeeping purposes.
2. The necessity of broadcasting DUT1 was largely unsupported. Most users apparently needing UT1 appeared to use UTC directly as an approximation UT1. Broadcast of DUT1

should be discontinued. Availability of UT1 for the purposes of orbit determination software and astronomical instruments could by achieved through publication via IERS Website and BIPM Circular T. The IERS is responsible for determining earth rotation parameters and has accepted responsibility for UT1 and its dissemination.

3. Redefinition of a new "**UTC**" is not necessary. The current definition may be adjusted to produce a broadcast time scale that capitalizes on the current organizational and systems support structure. This would achieve a long-term continuous time scale supported by timing centers coordinating their real-time realizations.

4. Divergence from solar time producing an increasing error that may be an issue in "civil" timekeeping purposes was estimated as a few seconds over three years. An error of approximately 1 hour would result in the year 2600. Subsequent step adjustment could maintain approximate agreement or advances in time keeping may lead to other solutions in the future. (E.F. Arias, B. Guinot, T.J. Quinn, "Rotation of the Earth and Time scales", Bureau International des Poids et Mesures, *Proceedings of ITU-R Special Rapporteur Group Colloquium on the UTC Time Scale*, Torino (Italy), 28 – 29 May 2003.)

5. The adoption of these recommendations will need to be considered within the formal ITU-R procedures. Consequently, submission and adoption of proposed changes to the ITU-R will determine the actual date for adoption. In consideration of that process the recommended date is suggested as 2010.

3.0 Conclusion

Report planned actions at CCTF.

Report Transition Plan to ITU-R SG 7

Revise ITU-R for circulation to Sector Members

Formal Recommendation submitted under Usual Procedures

U.S. submits proposed to submit revision to ITU-R Recommendation

5.0 Bibliography

BIPM letter to the Secretary General of the ITU

ITU-R Question on the Future of the UTC Time Scale