



# Report of the IAU Working Group on the Definition of Coordinated Universal Time

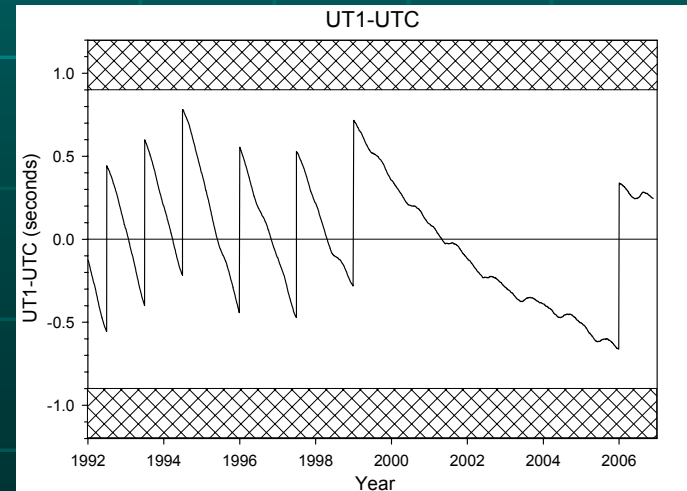
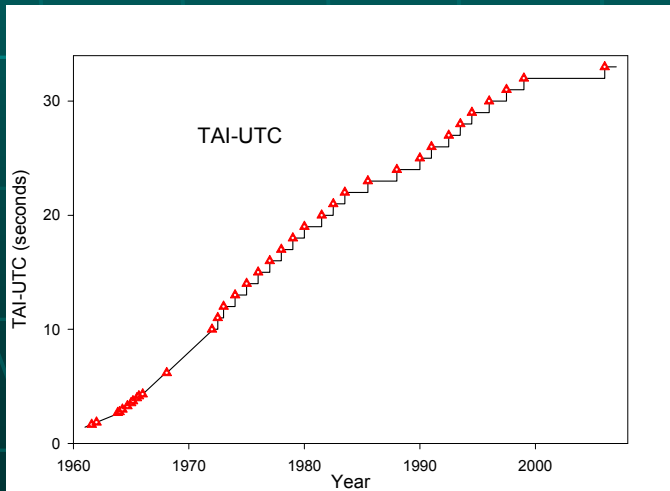
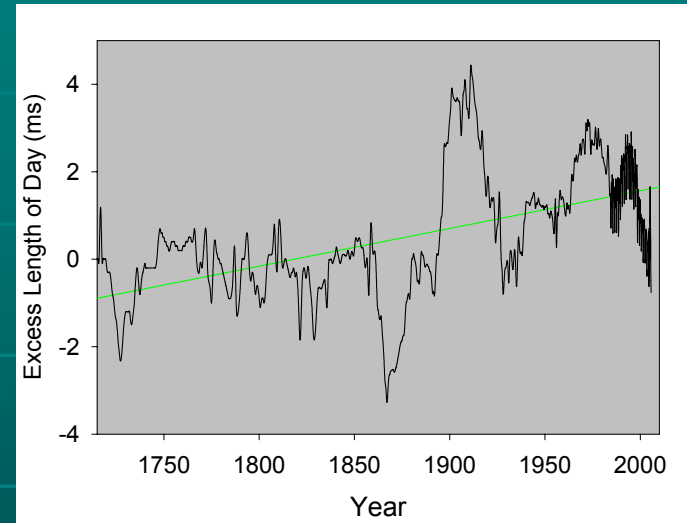
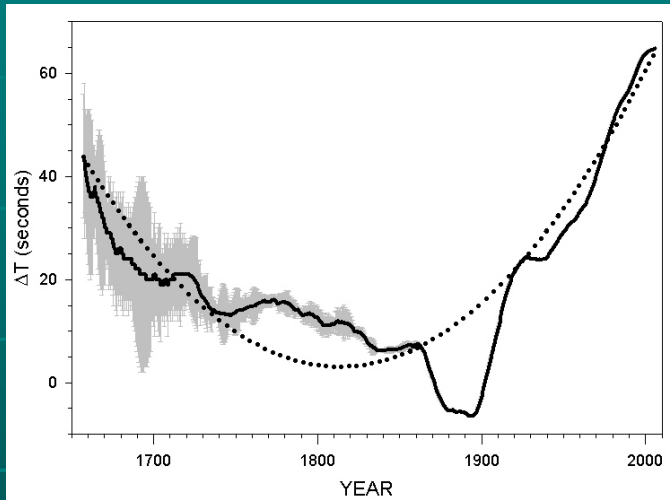
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# Background

- UTC definition derived from Recommendation 460 of the International Radio Consultative Committee (CCIR) in 1970
  - Implemented in 1972
  - $UTC = TAI + \text{integral seconds}$
  - Integral seconds adjusted as prescribed so that  $|UT1 - UTC| < 0.9 \text{ s}$
- In 2000 International Telecommunications Union - Radiocommunication Sector (ITU-R), adopted Question 236/7
  - What are the requirements for globally-accepted time scales for use both in navigation/telecommunication systems, and for civil time keeping?
  - What are the present and future requirements for the tolerance limit between UTC and UT1?
  - Does the current leap second procedure satisfy user needs or should an alternative procedure be developed?
- ITU-R WP 7A created a Special Rapporteur Group (SRG)
- IAU Working Group on the Definition of Coordinated Universal Time created in compliance with IAU Resolution B2 of the 24th IAU General Assembly



# Observations



# Issues

- Leap second insertions expensive and unpredictable
- Telecommunications, navigation and related fields moving toward need for single, internationally recognized uniform time scale
  - multiple *de facto* time scales
- Leap second insertion timing sequence
  - ... 58, 59, ?, 0, 1, ...

- Existing software takes advantage of the current definition and uses UTC as a substitute for UT1
- Legacy software used in the determination of orbital parameters of artificial satellites may use UTC as a substitute for UT1
- UTC vaguely related to the position of the Sun in the sky.

# Options Discussed

- Maintain the status quo
- Increase the tolerance between UT1 and UTC
- Periodic insertion of leap seconds
- Variable adjustments in frequency
- Redefine the second
- Substitute TAI for UTC
- Discontinue leap seconds in UTC

# Torino Colloquium (2003)

- The definition of UTC is likely to need to be changed from the current UTC standard and a means of transitioning to a uniform time scale could be accomplished by the creation of another time scale that might be called Temps International (TI) to clearly distinguish it from solar time.
- If a change were to be made, a date suggested to inaugurate that change could be 2022, the 50th anniversary of the UTC timescale. This date was influenced by the anticipated lifetimes of existing systems that would be expensive to change.
- TI likely a continuous atomic time scale, without leap seconds, synchronized with UTC at the time of transition.
- The responsibility for disseminating UT1 information should remain solely with the IERS.



# Special Rapporteur Group Report

- The creation of a new name not recommended because it would add significant complications in 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.
- The radio broadcast of DUT1 information should be discontinued since UT1 is available via IERS.
- The redefinition of a new "UTC" is not necessary
- Divergence from solar time, a possible issue in "civil" timekeeping is considered to be insignificant as the difference of approximately 1 hour would take until 2600 to accumulate. The recommended date for change is not later than 2010.



# U.S. WP7A Proposal to ITU-R Working Party (2004)

- Integral seconds adjusted so that  $|UT1-UTC| < 1h$
- Implementation in December, 2007
- Tabled at ITU-R meeting in 2004
- In ITU-R Working party discussion in 2005
  - Informal acceptance by France, Germany and Italy if implementation date changed
  - Rejection by UK



# Working Group Conclusions

## ■ Unanimous Agreement

- UT1 is a convenient measure of the Earth's rotation angle and an appropriate starting point, for the determination of local hour angles of celestial objects
- If a change in definition occurs, 5 to 10 years should be allowed to make any revisions in software

## ■ Nearly Unanimous Agreement

- Necessary to insert more than one leap second per year in the future
- Important to have a time scale without discontinuities in epoch for use in practical applications
- Desirable to have civil time "close" to solar time
- Financial cost to revise legacy software to allow for a departure from the current definition of UTC is not too high to make such an option worth considering
- Modern clocks do not generally permit the leap second to be labeled unambiguously

# Working Group Conclusions

- General Agreement or Ambivalence
  - Current definition of UTC is not adequate to meet the needs for practical precision timekeeping for the foreseeable future
  - Not important to continue the radio broadcast of DUT1 (the low-precision estimate of UT1-UTC) for navigators
- No Agreement (wide range of opinion)
  - Use of TAI as a time scale in addition to UTC should be encouraged
  - Insertion of leap seconds could create significant safety of life concerns
  - Importance of making a decision regarding possible changes in the definition of UTC before the implementation of navigational time scales in GALILEO and GPS III
  - Retaining the name “Coordinated Universal Time” as the name for the standard worldwide time scale.

# Current Status (August, 2006)

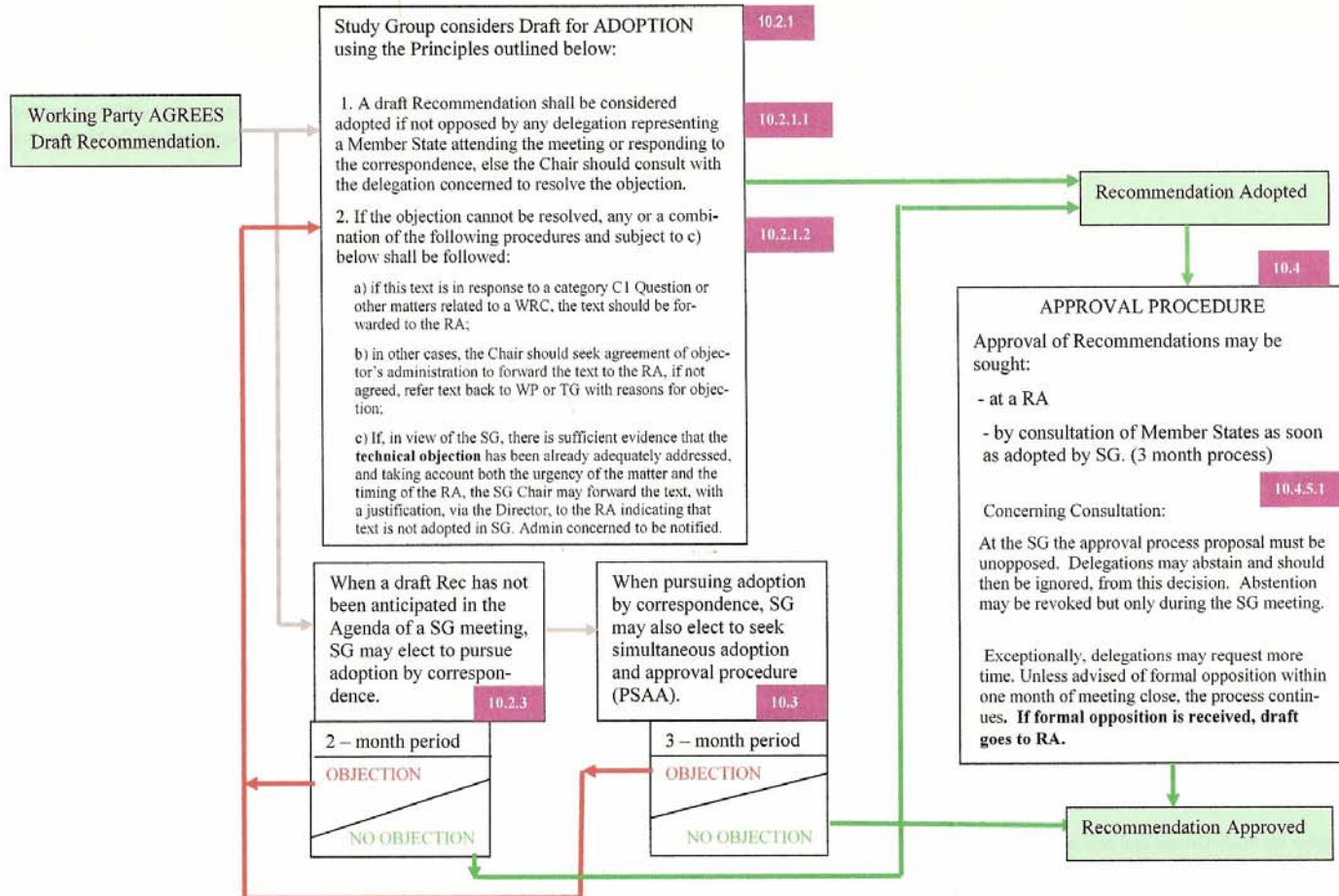
- To be discussed again at the meeting of ITU-R International Working Party 7A in Geneva, 29 August – 1 September 2006
- Expected that the ITU-R Working Party 7A will request the Special Rapporteur Group to distribute its report to the ITU-R Sector Members along with the current version of the proposed draft amendment
- Expected that comments will be requested from the Sector Members in time for discussion at the September, 2007, meeting of the Working Party
- An ITU-R Working Party 7A proposal could be drafted in September 2007

## ITU-R RECOMMENDATION (New or Revised) AND QUESTION APPROVAL PROCESS

(From ITU-R Resolution 1-4, modified by RAG 12)

(also applied to Recommendation deletion)

■ = relevant section from ITU-R Res. 1-4



# Recommendations

- Recognizing that the ITU-R is unlikely to prepare a formal ITU-R proposal for consideration by sector members before the autumn of 2007, the Working Group makes the following recommendations.
  - **A.** In response to the expected distribution of the ITU-R request in the autumn of 2006, the General Secretary of the IAU in consultation with the President of Division 1 and the Presidents of the Commissions within IAU Division 1, reply noting the following points:
    - There is no strong consensus within the IAU either for or against a proposed change in the definition of UTC.
    - The IAU requests that a sufficient time be allowed between the adoption of any change in definition and its date of implementation to permit astronomical software to be changed with the least cost and inconvenience. It is suggested that that time be at least five years.
    - The IAU requests that it be consulted as part of any formal action taken to change the definition of UTC.
  - **B.** The current Working Group on the Definition of Coordinated Universal Time be dissolved.