ITU-R WORKING PARTY 7A
SPECIAL RAPPORTEUR GROUP
ON UTC

The Future of the UTC Timescale

Civil GPS Service Interface Committee

Timing Subcommittee

11 September 2001

UTC ISSUES RAISED

- Problems raised on discontinuous nature of UTC, i.e. leap seconds
  - Awareness of upcoming leap second (Availability of Notice)
  - User System design requires manual or overly complex inclusion
  - Discontinuous operation simply not possible
- Leap second basis re-examined by IAU and URSI
  - Transition to UTC integrated Atomic Time with Solar Time
  - Tolerance of $|UT1 - UTC| < 0.9$ s considered essential for Celestial Navigation Users

SRG PURPOSE

- Use of UTC and leap second procedure is established by ITU-R Recommendation TF.460-5
- UTC concerns raised to the ITU-R and undertaken by adopting
  - Question ITU-R 236/7 (2001), The Future of The UTC Time Scale
- SRG formed to:
  - Focus studies into this highly significant question and leap second issues
  - Address additional concerns raised concerning Satellite Systems
    - Independent System Time (e.g. GPS Time)
    - Use of TAI
  - Investigate Proposed Changes to UTC in coordination with ITU-R Sector Members and CCTF
  - Report Results and Suggested Recommendations to ITU-R

Question ITU-R 236/7 (2001)
FUTURE OF THE UTC TIMESCALE

The following questions are to be studied:

1. What are the requirements for globally-accepted time scales for use both in navigation and telecommunications systems, and for civil time-keeping?

2. What are the present and future requirements for the tolerance limit between UTC and UT1?

3. Does the current leap second procedure satisfy user needs, or should an alternative procedure be developed?

ITU-R RECOMMENDATIONS on UTC

Recommendation ITU-R TF.460-5 (1970-1974-1982-1986-1997)

- All standard-frequency and time signal emissions should conform as closely as possible to UTC.
- The procedure for the insertion of leap seconds into UTC is described
- Ensure UTC does not differ by more than 0.9 seconds from UT1

Further application of UTC :

- Recommendation ITU-R TF.486-2, "Use of UTC Frequency as Reference in Standard Frequency and Time Signals Emissions", (1974-1978-1998);
- Recommendation ITU-R TF.535-2, "Use of the Term UTC", (1978-1982-1998);
- Recommendation ITU-R TF.458-3 "International Comparisons of Atomic time Scales" (1970-1978-1990-1998);
- Recommendation ITU-R TF.536, "Time-Scale Notations", (1978).

POTENTIAL SYSTEM IMPACT

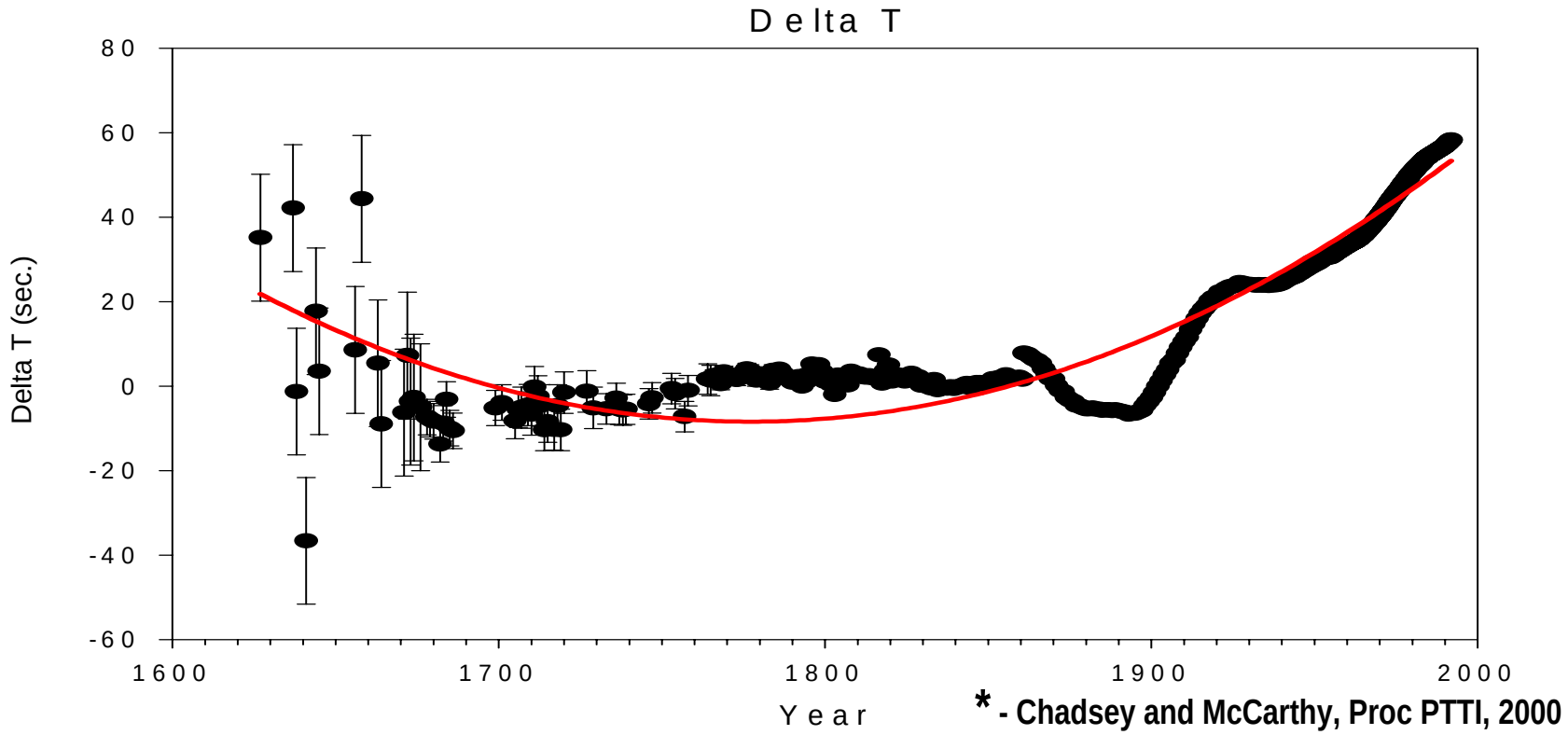
- Satellite Navigation Systems (U.S.)
  - GPS - UTC(USNO)
  - WAAS Synchronized to GPS and UTC(USNO)
  - LORAN-C
- Telecommunications Systems
  - Increasing Use of GPS to Obtain Precise Frequency
- Computer Networking (Internet)
  - NTP Servers disseminating UTC
- Broadcast Services
  - WWV, WWVB, WWVH
- Scientific Uses
  - Geophysical Systems Using GPS Extensively

UT1 AND EARTH ROTATION*

Earth deceleration

Tidal

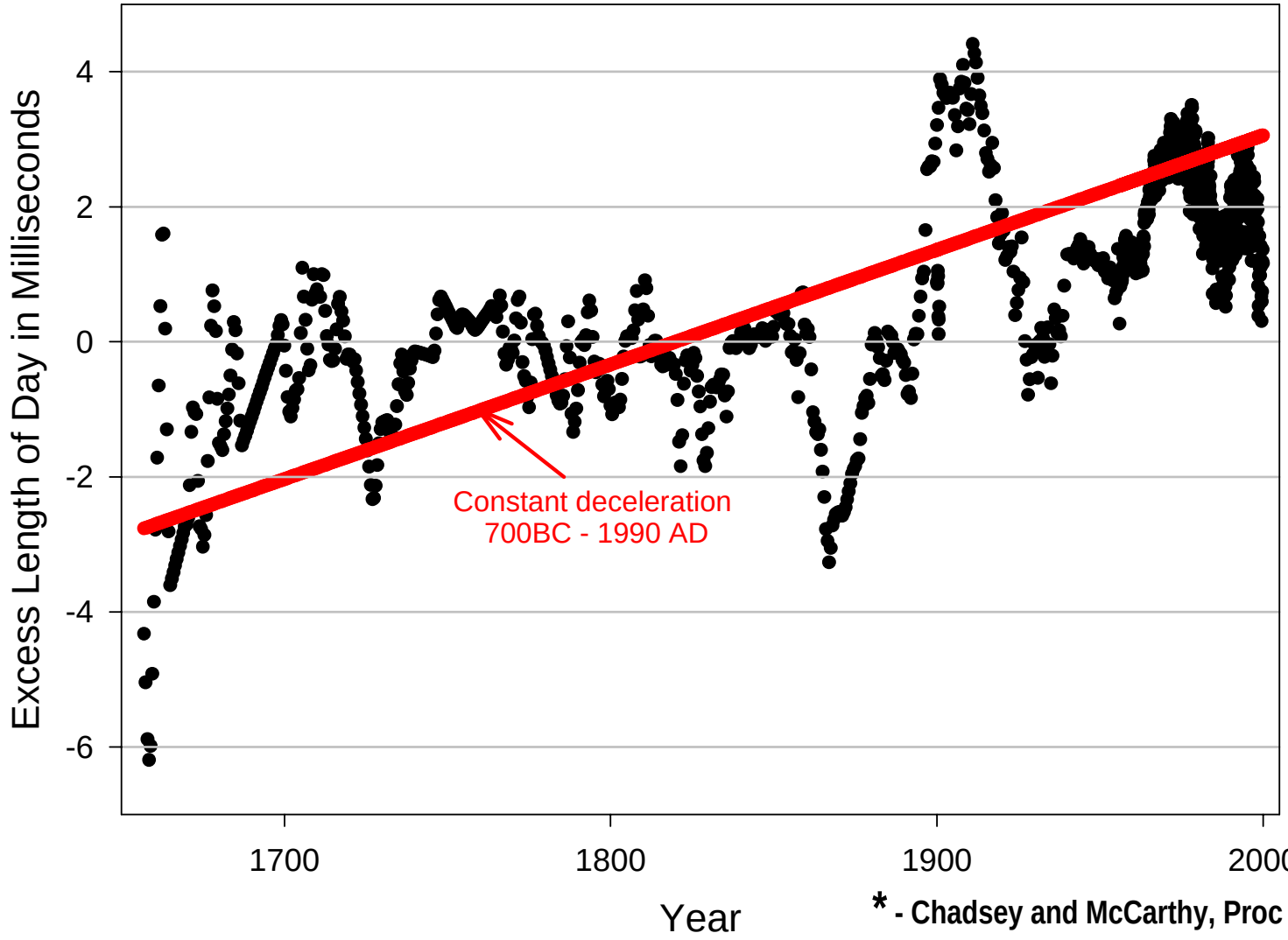
Change in figure



*** - Chadsey and McCarthy, Proc PTTI, 2000**

International Telecommunication Union

CHANGE IN LENGTH OF DAY*



* - Chadsey and McCarthy, Proc PTTI, 2000

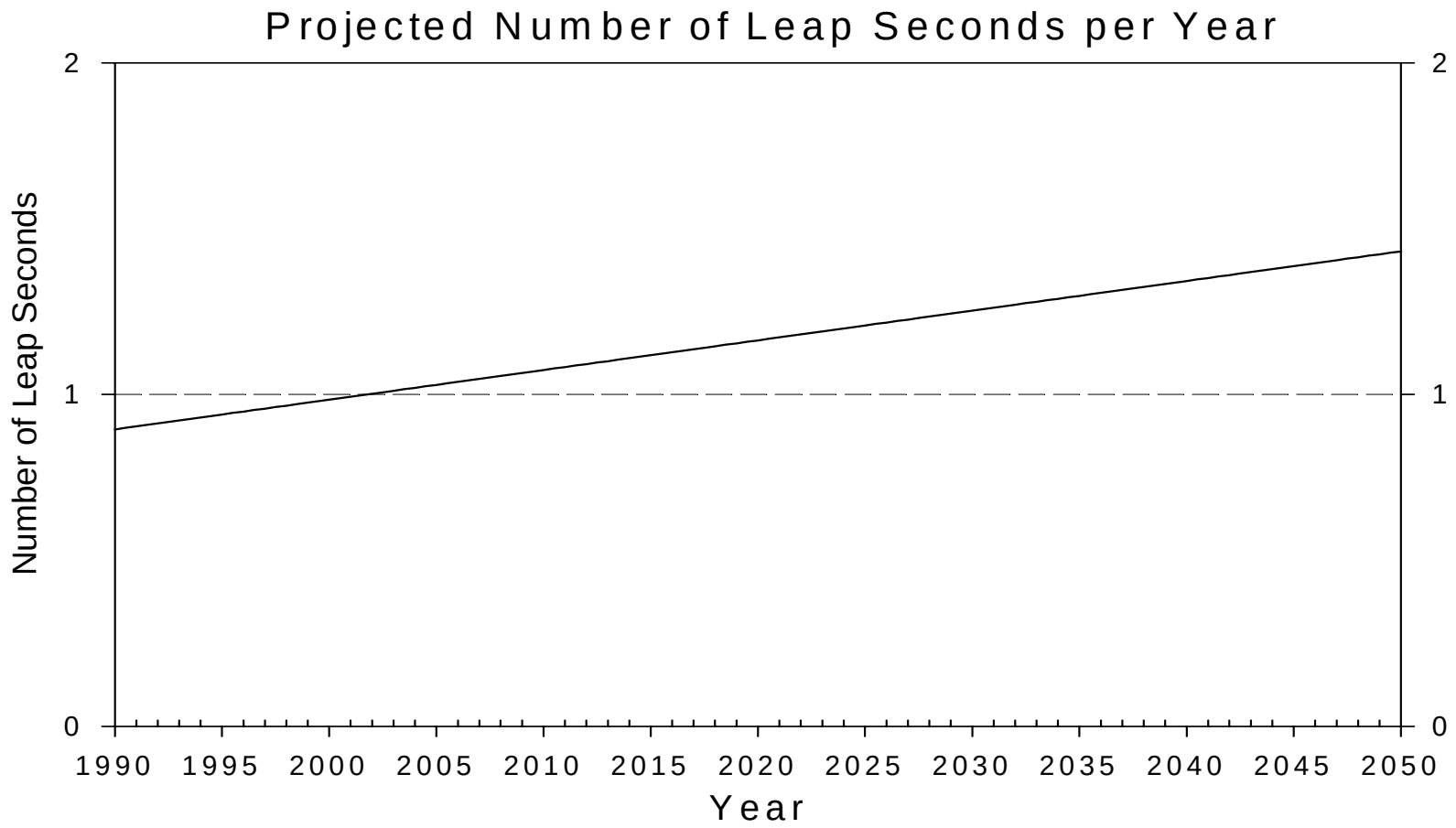
ELEMENTS OF THE QUESTION

1. Requirements of Time & Frequency Reference:
   - Accuracy, Stability, Based on the SI Second
   - Uniformity and Accessibility
   - Reliability
   - Relation to Legal Time
   - Coverage Needed - Global?
   - Relation to Civil / National Timekeeping ?
2. Tolerance
   - Could a Greater Tolerance be Accommodated?
3. User Needs and Alternatives
   - Availability of Leap Second Information for Users
   - Amplify Possible Alternatives
   - Relationship of System Internal Time to Time Scales

RANGE OF OPTIONS

1. Maintain the Status Quo - Use UTC as currently defined
   - Additional Actions:
     - Clarify Time Scales Available and Considerations for Use
     - Provide more advanced Notice and Availability
     - Examine utility of a Navigation Time Scale (Celestial Users)
2. Modify Leap Second Tolerance and Occurrence
   - Increase Tolerance of |UTC – UT1|
   - Establish Longer Prediction Interval and Frequency of Occurrence
   - Establish Fixed Interval Adjustment with Multiple Leap Seconds
   - Correction at Predicted Intervals Based on Deceleration Model, Re-evaluated at Fixed Intervals
3. Transition to Another Timescale
   - International Atomic Time (TAI) - (Navigation Time Scale for Celestial Users may be needed)
   - New Time Scale Based on Re-Definition of SI Second

STATUS QUO*



* - Chadsey and McCarthy, Proc PTTI, 2000

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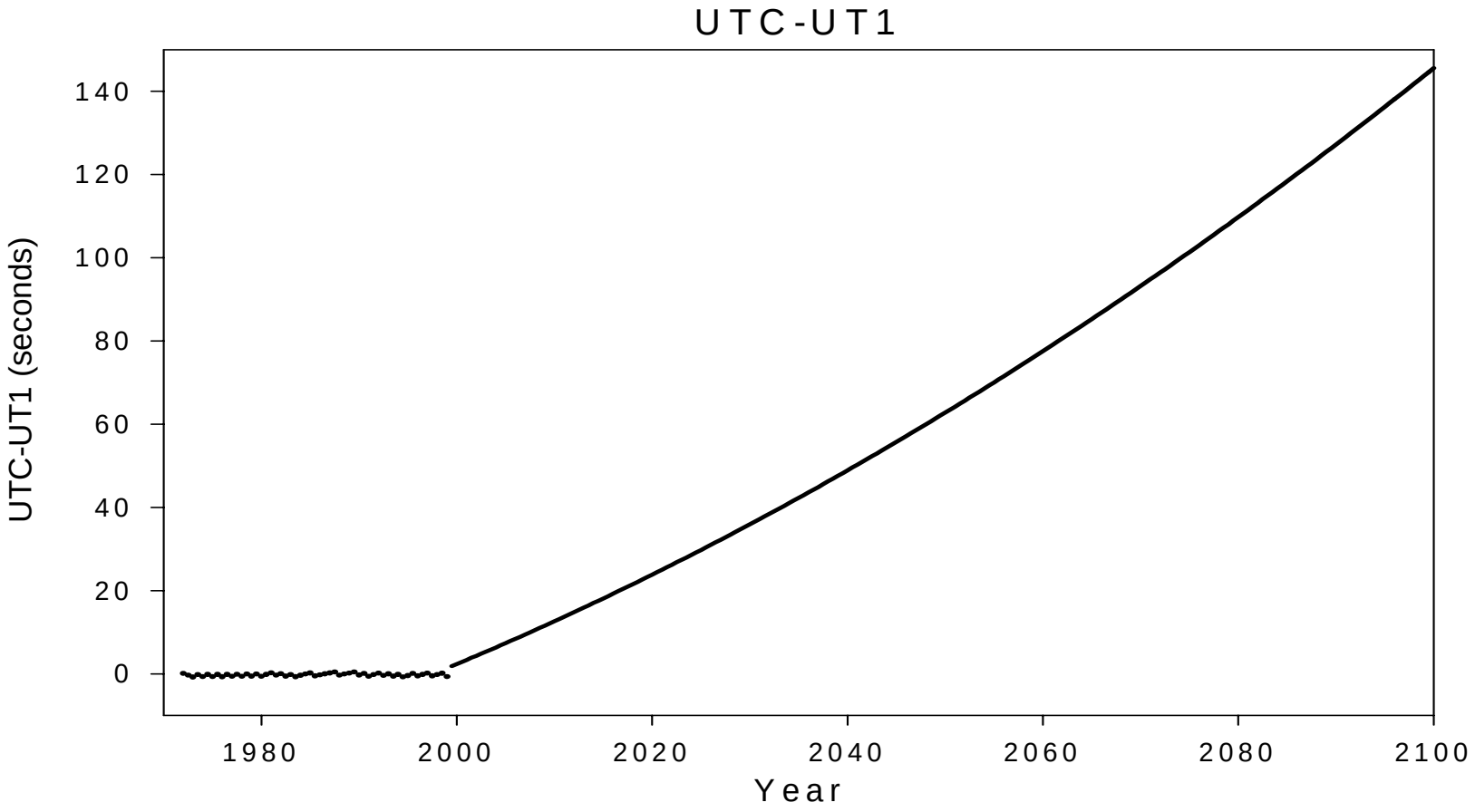
DISCONTINUE LEAP SECONDS*



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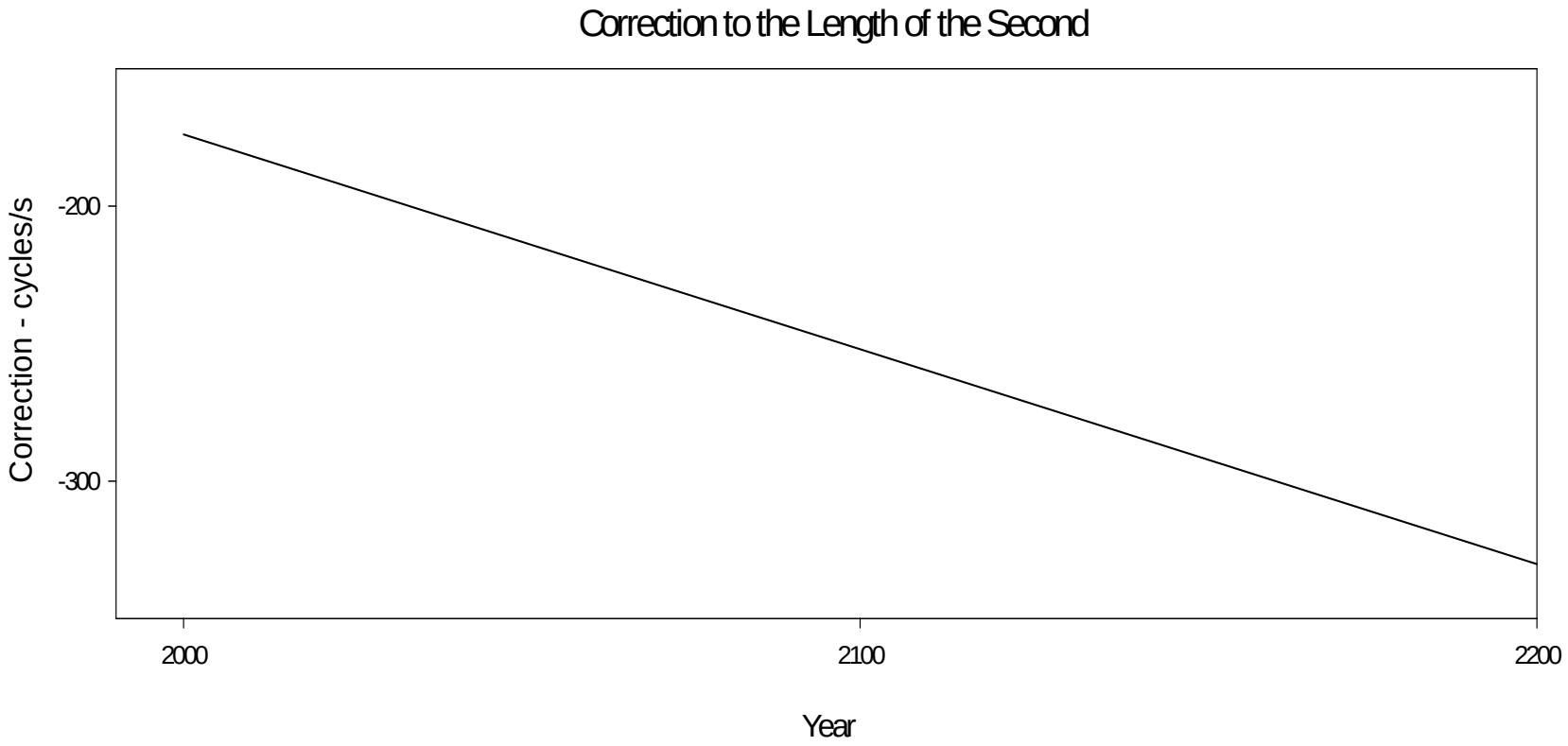
REDEFINE THE SECOND*



* - Chadsey and McCarthy, Proc PTTI, 2000

STUDY PLAN ACTIVITIES

Interaction with Technical Societies and Agencies Needed

- Notices in Journals and Agencies Newsletters
- Coordination With ITU-T
- Telecommunications and Navigation Users

SRG Meetings Scheduled Concurrent with PTTI 2001 and EFTF 2002

Anticipate Final Report for ITU-R WP7A Meeting October 2002

SRG ACTIVITIES

The SRG working by e-mail coordinated by the Chairman

ronald.beard@ties.itu.int

Contributions invited for submission to the SRG

To the Chairman by electronic mail

Attendance at SRG Meetings

Participation invited

To gain the widest consensus possible, it is requested that participants represent a technical area agency or society participation