

# **Leap Second Results of the survey made in Spring 2002 by the IERS**

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# General background

- Since 1972, leap seconds have been added on December 31 or June 30, at the rate of about one every 18 months in order to maintain UTC close to UT1 within 1 second. The last leap second took place on 1999.0. The next leap second will not likely take place before 2006.0
- The Earth Orientation Center of the IERS at Paris Observatory is in charge of the leap second announcement
- The relevant bulletins are:
  - Bulletin C: Announcement of the leap seconds in UTC
  - Bulletin D: Announcement of the value of DUT1 truncated at 0.1s for transmission with time signals.

# Purpose of the survey

- Find out the strength of opinion in the community of IERS users for maintaining or changing the present system using regular introductions of leap second.
- Complement the surveys made by URSI/NIST and Communications Research Laboratory CRL

# Questionnaire

Are you satisfied by the current UTC determination method with leap second adjustments?

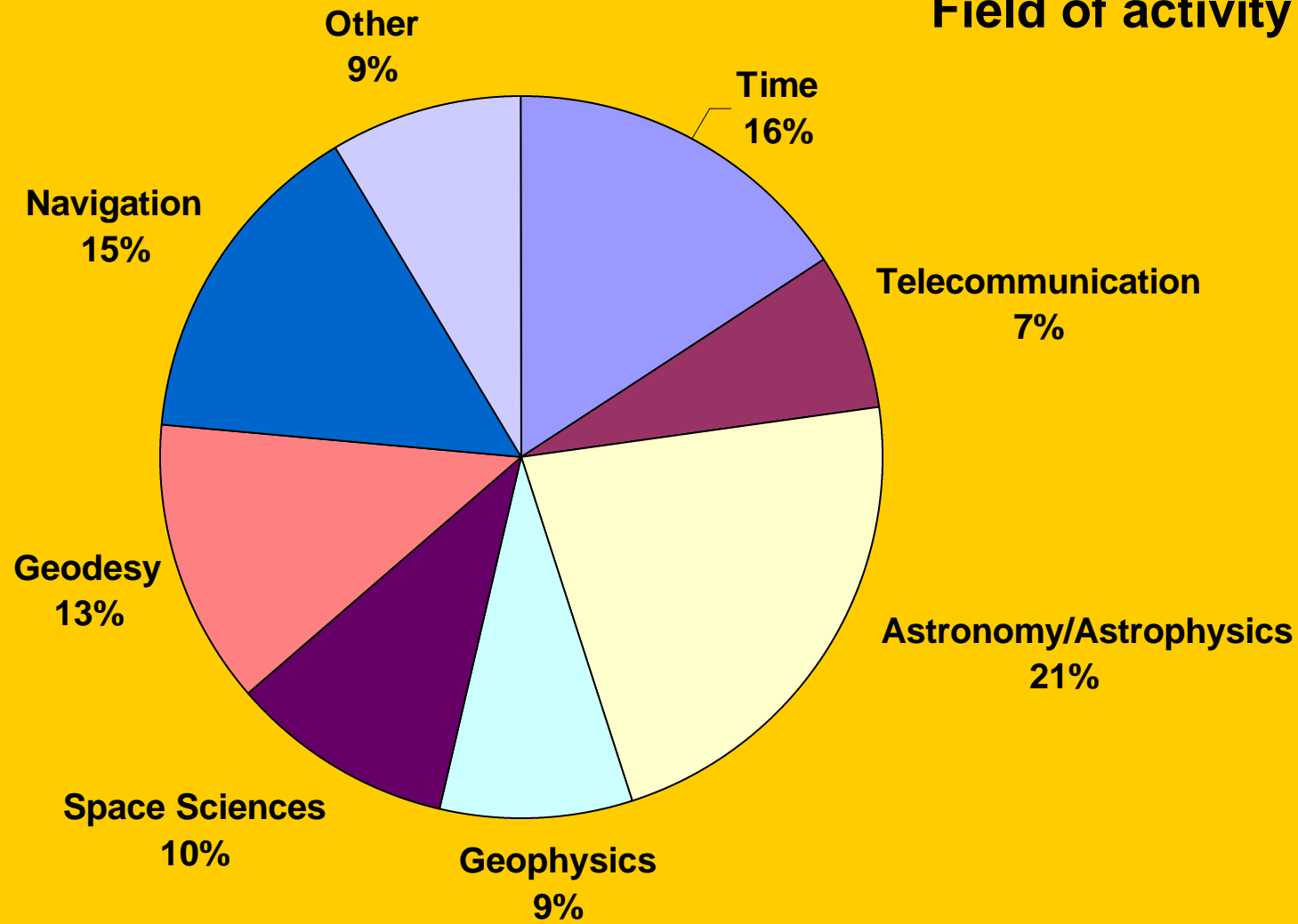
If NO, do you think it would be better to change the determination method of UTC?

YES → which alternative solution would you favour?

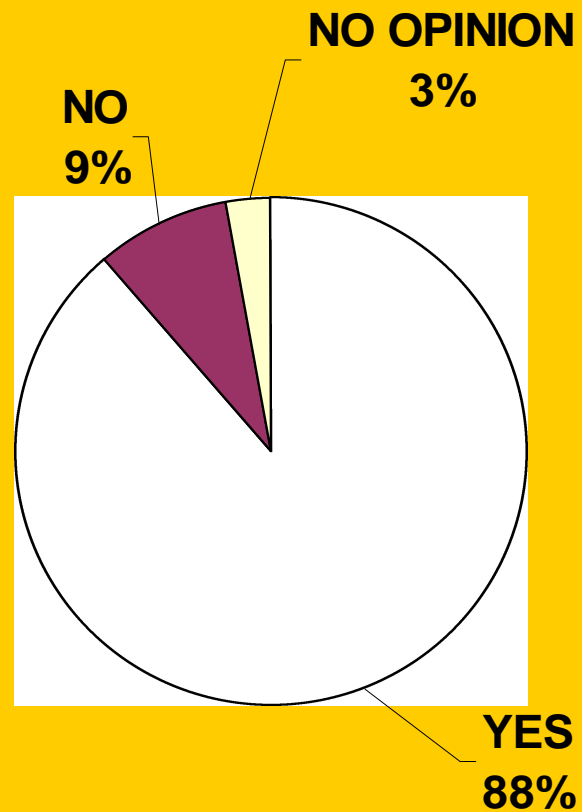
- a. No leap second
  - a.1 UTC without further leap seconds
  - a.2 Use TAI
- b. Increase tolerance for  $|UT1-UTC|$
- c. Smooth over leap second step
- d. Redefine the second
- e. Some other possibility ?

NO → why?

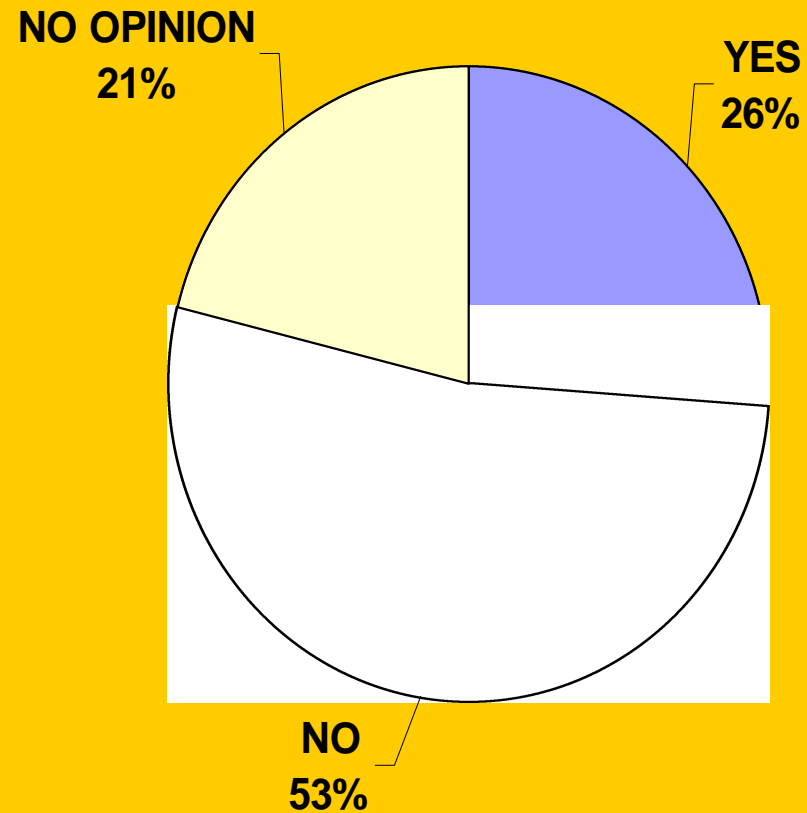
## Field of activity



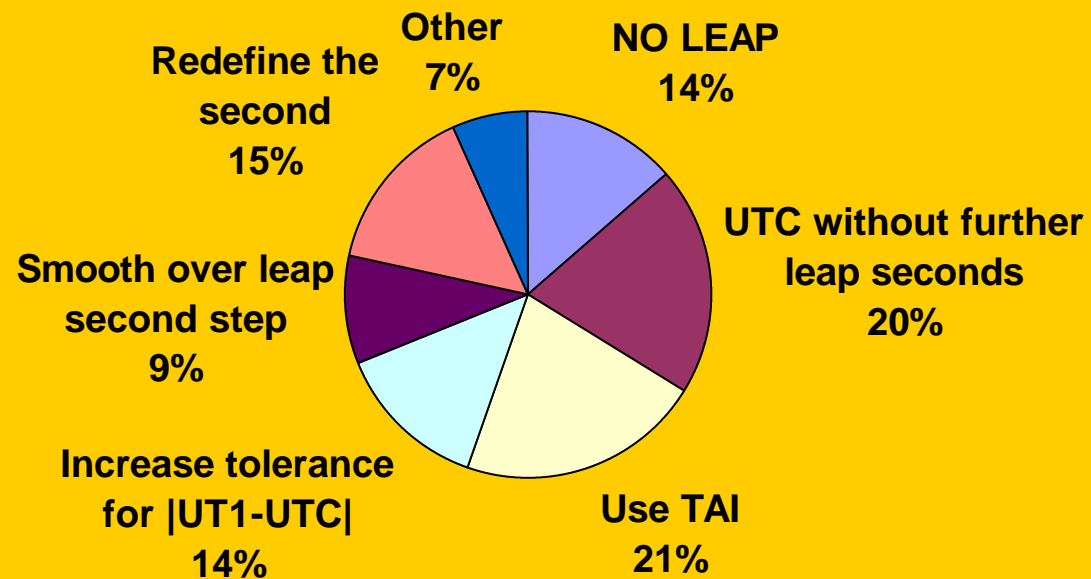
### 3 - Are you satisfied by the current UTC determination method with leap second adjustments?



## 4 - Do you think it would be better to change the determination method of UTC?

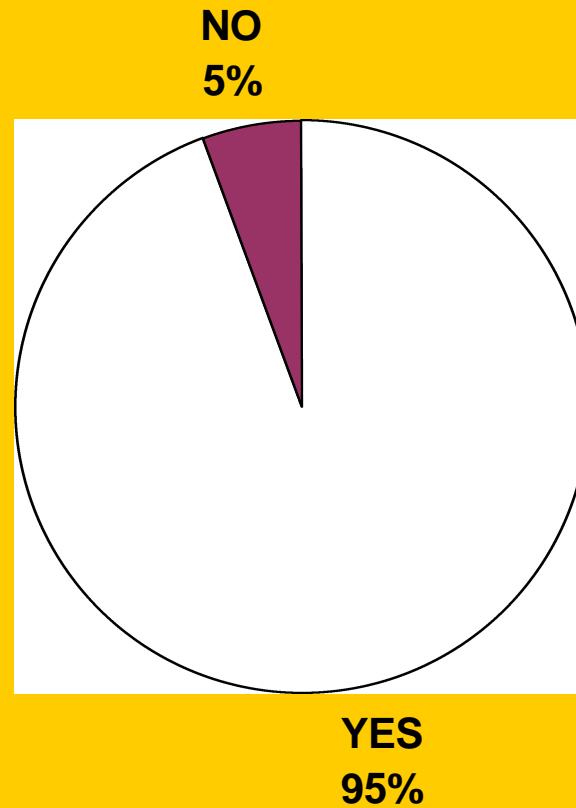


**4 - 1 If YES (26% of non satisfied users ), which alternative solution would you favour?**





## 6 - Is the present Bulletin D appropriate?



# General analyses of the results

- 247 responses over 1000 , many responses grouped
- 88 % are for the statu-quo: no change in the current definition. 9 % are not satisfied. 3% have no opinion.
- Among propositions of a new definition (26% of non\_satisfied users)
  - 20% for UTC without further leap second
  - 21% use TAI
  - 14% increase tolerance UT1-UTC

# Some general concerns

- The only real question is whether or not we want civil time in close agreement to the astronomically determined time (UT1)
- The decision to change the procedure should be taken by users, not by the time-scale makers.
- The name UTC should be conserved, even if the definition is changed.
- UTC is the basis of the legal times in the countries, and dropping UTC should imply the adjustment of local legislations

# General arguments for statu-quo

- No strong argument to change. The current system works
- Good compromise between accurate time scale and solar time : practical identification of UT1 with UTC
- Alternative time scales exist for scientific applications (TAI, GPS time scale).
- Any changes in these areas will likely cause substantial confusion.
- In particular, risk of confusion and problems when a large jump in the case of the increase of the tolerance UT1-UTC
- In a few decades who will remember the origin of the procedure?
- Important costs for software modifications

# General arguments for a change

- A discontinuous time scale is not convenient
- Leap seconds are cumbersome
- Ignoring leap seconds will not be a significant problem for civil purposes

# Astronomy / astrophysics

- Telescopes controls often based on the identification of UT1 and UTC : increase of the tolerance with diffused UTC - UT1 would damage the common practice
- Changing time scales : risk of confusion for astronomical events datation (eclipses..)
- Breaking the link between astronomy and time would damage astronomy

# Time

- UTC not convenient for timestamps : it cannot be automatically produced because leap second should manually introduced
- Whatever option for the redifinition of UTC is chosen, it should be published well in advance of being implemented (say 3 years), to allow any assumptions in existing systems to be checked.
- UTC dissemination by telecom : Many devices and programs are designed with the leap second in mind

# Navigation by radio/satellite/GPS/GNSS

Leap seconds cause a lot of pain and suffering for precise navigation using GPS

## Celestial Navigation

Tens of thousands of marine navigators would have to be equipped with revised sight reduction procedures and re-educated



# Geophysics

- Sismology : time discontinuity caused by the leap second is very disadvantageous for time-stamping continuous geophysical measurements such as seismic.
- Geodynamics : Length of day cannot be derived from the conventional EOP UT1-UTC, UT1-TAI would be more convenient.

# Software development

- Two opposed opinions :
  - Problems created by leap seconds are not significant problems
  - Any change in the current method of dealing with UT1-UTC would require significant software modifications, testing, documentation changes and training of the system operators
- Forecasts should be extended (to one or two years)
- A complete leap-second "history" (covering the past and the future) need to be published in a well-standardized form suitable for computers, and updated as required.

# Conclusions of the survey

- About 25% of responses to the questionnaire
- A high majority (88%) of the responses of the survey are for the statu-quo, no change. 9% of users are not satisfied. 3% have no
- Among propositions of a new definition (26%) ,
  - 20% for UTC without further leap second
  - 21% use TAI
  - 14% increase tolerance UT1-UTC
  - 14% : No leap second