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The future of UTC – a British perspective

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ITU/BIPM Workshop on the Future of the International Time Scale

19 September 2013

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Aims of the talk

- The importance of UTC
- How UK policy on the future of UTC is decided
- Why the UK opposes the proposal to end leap seconds
- A UK perspective on the available solutions

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The importance of UTC

- The international reference time scale
- Underlies all disseminated time scales
  - GNSS, radio time signals, internet (NTP), radio stations

→ UTC is the basis of civil timekeeping world-wide
  - Not possible for individual countries or regions to adopt another reference time scale

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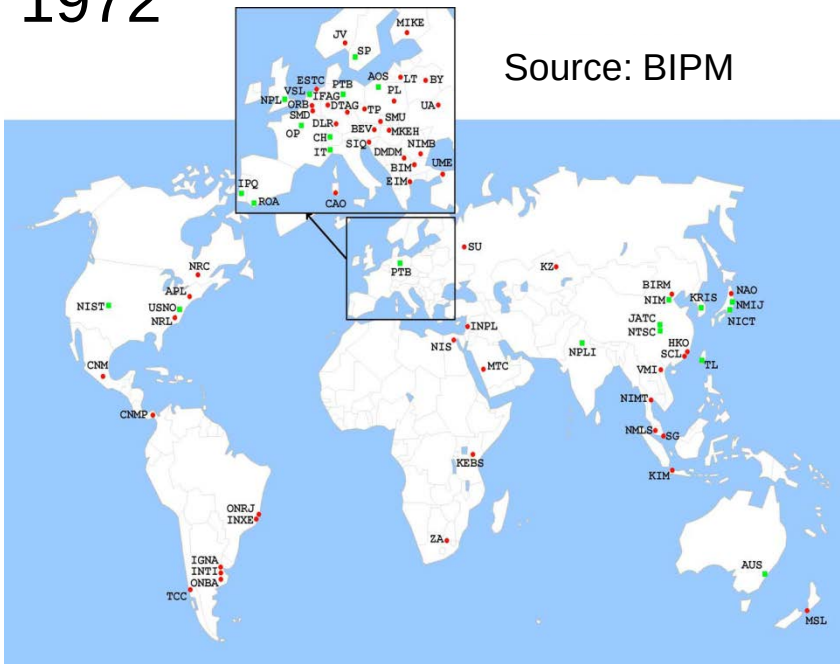
Characteristics of UTC

- A ‘compromise’ time scale:
  - Stability of atomic time TAI: SI second
  - Aligned with UT1 (Earth time) to within 1 s
- Adjustment by 1 s steps since 1972
- An international collaboration
  - Computed by the BIPM
  - More than 70 contributing timing centres



Source: BIPM

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Proposals to end leap seconds

- Idea first raised in public in 1999

INNOVATION

GPS and Leap Seconds
Time to Change?

Dennis D. McCarthy, U.S. Naval Observatory
William J. Klepczynski, Innovative Solutions International

Since ancient times, we have used the Earth's rotation to regulate our daily activities. By noticing the approximate position of the sun in the sky, we knew how much time was left for the day's hunting or farming, or when we should stop work to eat or pray. First sundials, water clocks, and then mechanical clocks were invented to tell time more precisely by essentially interpolating from noon to noon.

As mechanical clocks became increasingly accurate, we discovered that the Earth does not rotate "like clockwork," but actually has a slightly nonconstant rotation rate.

Just as leap years keep our calendar approximately synchronized with the Earth's orbit about the Sun, leap seconds keep precise clocks in synchronization with the rotating Earth, the traditional "clock" that humans have used to determine time. Coordinated Universal Time (UTC), created by adjusting International Atomic Time (TAI) by the appropriate number of leap seconds, is the uniform time scale that is the basis of most civil timekeeping in the world. The concept of a leap second was introduced to ensure that UTC would not differ by more than 0.9 second from UT1, the [illegible]

seconds. While resetting the GLONASS clocks, the system is unavailable for navigation service because the clocks are not synchronized. If worldwide reliance on satellite navigation for air transportation increases in the future, depending on a system that may not be operational during some critical areas of flight could be a difficulty. Recognizing this problem, GLONASS developers plan to significantly reduce the outage time with the next generation of satellites.

Navigation in

Source:
GPS World
Nov 1999

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Proposals to end leap seconds

- Idea first raised in public in 1999
- First formal proposal submitted to WP7A in 2004
- Considered at ITU-R Radiocommunication Assembly meeting in Jan 2012
  - Only 2 options formally considered at RA-12:
    - End leap seconds in UTC while retaining the name
    - Keep the present system unchanged
  - No agreement
  - Call for a broader debate

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UK response to the proposal

- 2005: UK position decided at minister level
  - Based on evidence presented to WP7A, consultation with other government departments and agencies, and submissions from scientific institutions
- 2008: Policy reviewed by different minister
  - UK then alone in opposing the proposal
- 2011: Policy reconfirmed prior to RA-12
  - New minister following a change of government
  - Decision supported by ministers from all major departments

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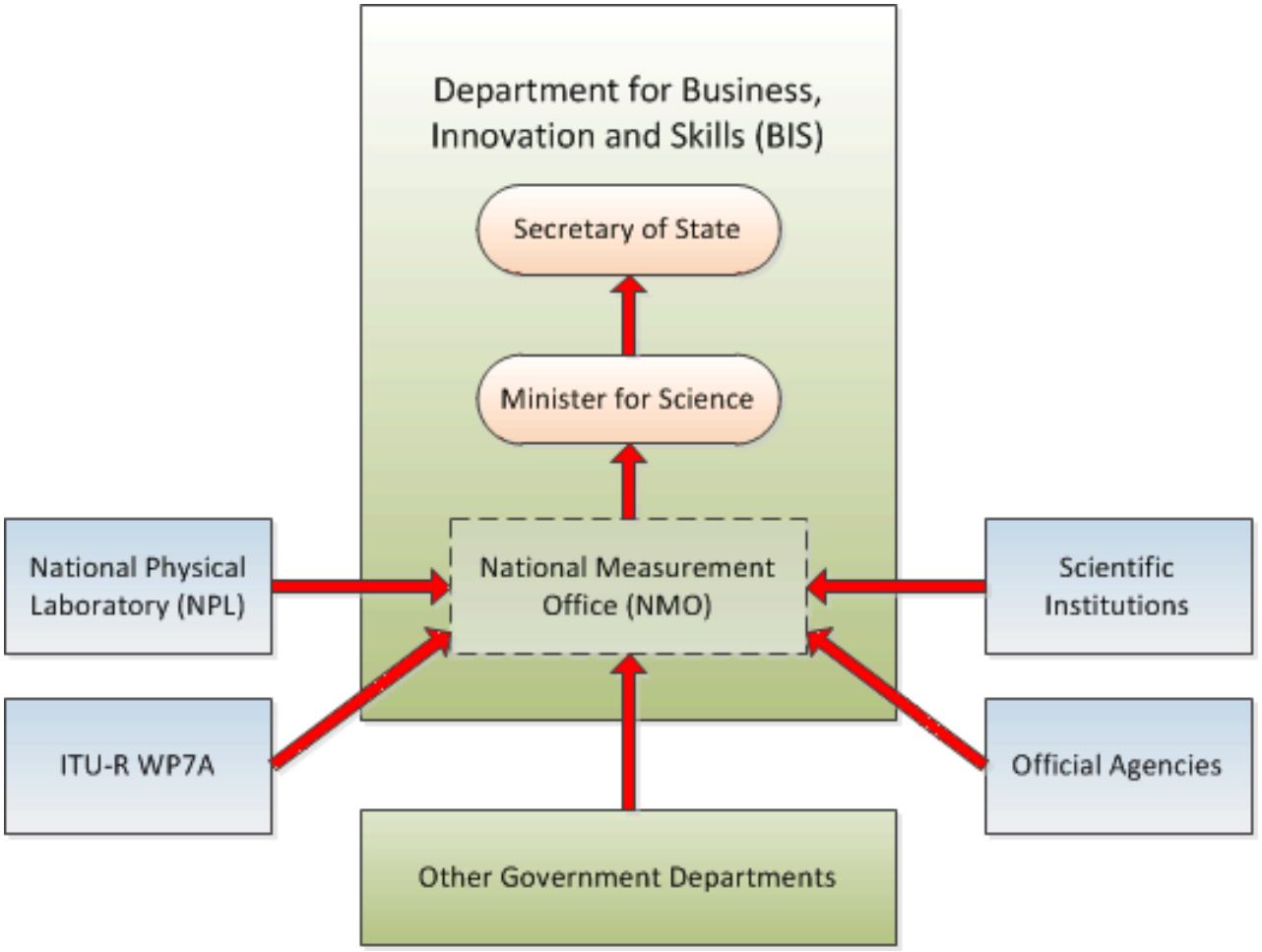
Formulation of UK policy on the leap second

2005 and 2008:



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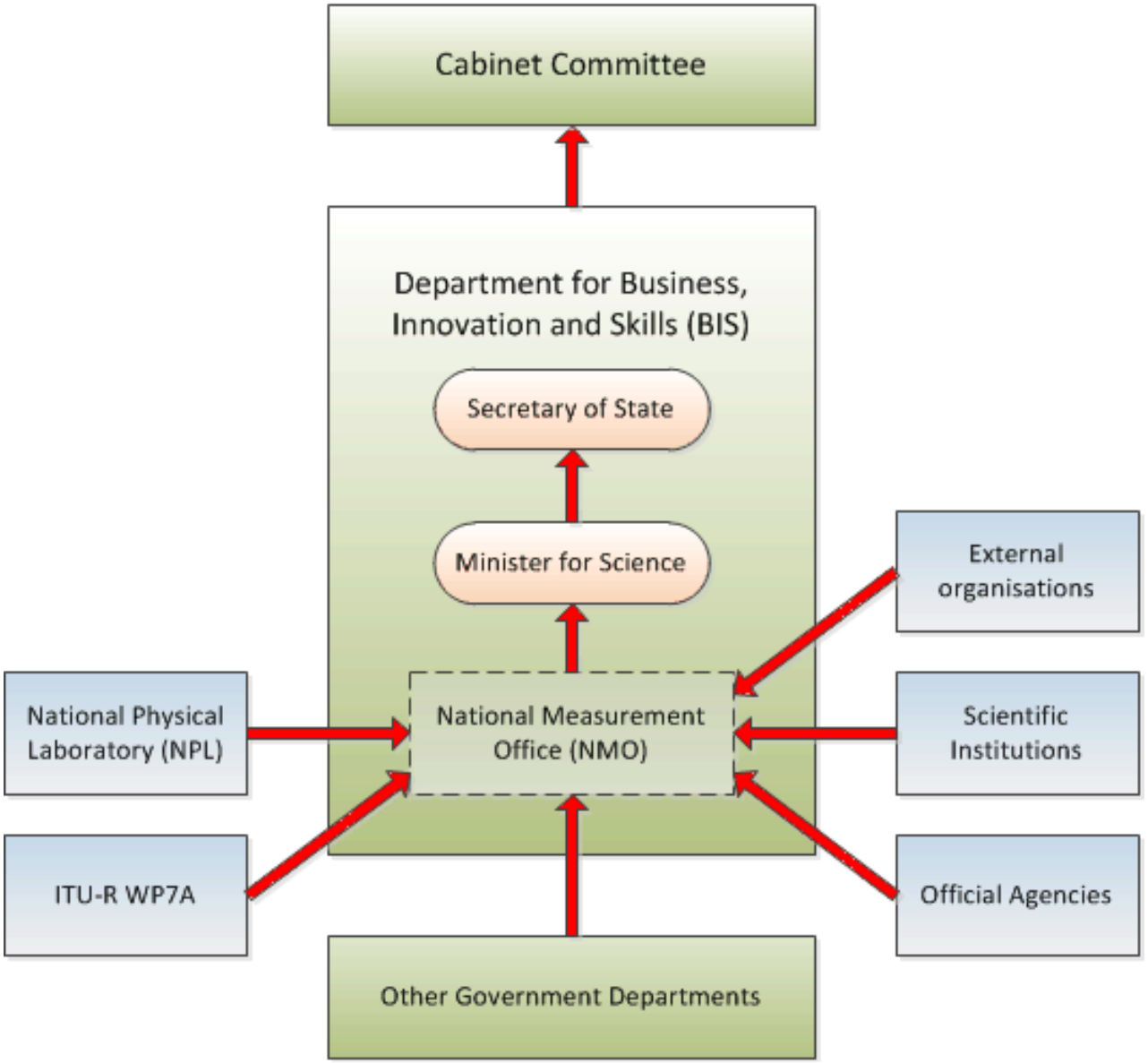
Formulation of UK policy on the leap second

2011:



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Reasons for the UK policy decision

- Ending leap seconds considered the most significant change in civil timekeeping for centuries
  - Breaks link between civil time and the Earth

- Lack of evidence for severe problems
  - Technical solutions should eliminate many problems
  - Leap seconds in use since 1972
- Other less drastic options available
  - Eg. use TAI alongside UTC
- Change of name seen as essential

UK legal time

- UK laws refer to Greenwich Mean Time GMT
  - UT1 is the modern form of GMT
  - UTC provides an adequate representation of ‘GMT’
- If leap seconds are ended, UK laws will have to be changed to refer explicitly to UTC (or TI?)
- Procedure is not difficult
- Some adverse media comment likely

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Importance of GMT to UK

- Loss of the name GMT not a major factor in UK government considerations

- Example: UK government consultation in 2011 on moving UK to Central European Time
  - If adopted, no longer possible to refer to UK civil time as GMT
  - Debate focused on economic and social effects, not loss of GMT

Importance of GMT to UK

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20 February 2011 Last updated at 15:05

Plan to bring UK

COMMENTS (1)

Longer evenings could move a ... with a government plan to move ... forward an extra hour.

A "tourism strategy" will include a p... the clocks in line with most of Euro... lighter evenings but darker mornir...

Tourism chiefs and safety campai... the move, but there are fears in ... road accidents.

Ministers want to be satisfied the ... the plan before giving the go-ah...

Last year, Prime Minister David ... consider a switch.

"The argument will be won when peop... comfortable with the change," he said in August.

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28 October 2011 Last updated at 16:11 GMT

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UK clocks change trial being considered

COMMENTS (661)

The government is considering moving the UK's clocks forward by an hour for a three-year trial period.

Supporters say lighter evenings would reduce traffic fatalities and boost exercise

Ministers are writing to counterparts in Scotland, Wales and Northern Ireland to seek a UK-wide consensus on a trial.

It would see the UK adopt Central European Time, with BST plus one hour in summer and GMT plus one in winter.

But a spokeswoman for the Scottish government said its "established position" was that there was "no case for a change to existing arrangements".

'Double summertime'

If adopted, the change would mean that for one autumn, the clocks would not go back, synchronising the UK with much of Europe and meaning that

Related Stories

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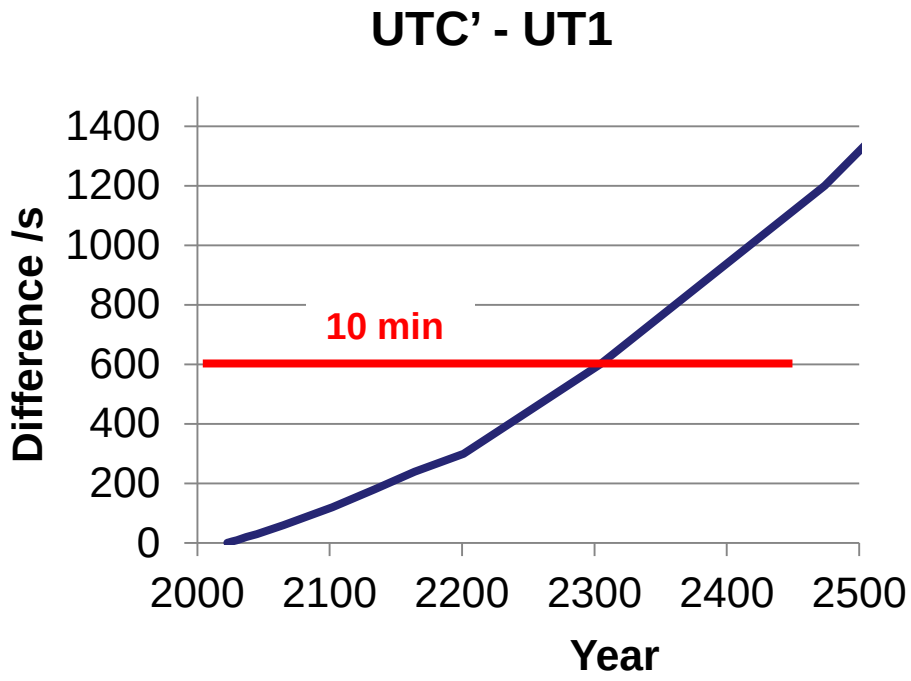
'No evidence' for daylight saving

Consequences of ending leap seconds

- Quadratic divergence between UTC' and UT1
- One estimate:
  - 1 minute in ~50 years
  - 10 minutes in ~300 years
  - 1 hour in ~900 years



Source: Steve Allen, Lick Observatory, Univ. California

- Should be agreement on how this divergence can be corrected before leap seconds are ended

Options for correcting the divergence

1. Bigger, less frequent steps in UTC’
   - Eg. leap minutes, leap hours
     - Would provide the required corrections
     - Difficult and costly to implement
     - Bigger steps likely to create bigger problems
     - Does not provide an unstepped time scale

2. Change civil time offsets from UTC’ rather than UTC’
   - Similar to time zone change
     - No need for global consensus
     - Messy in long term

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Change in the ‘day’ if leap seconds ended

- If leap seconds are ended, the ‘day’ is in effect redefined
- Now:

  The time taken by the Earth to turn once on its axis
- If leap seconds are ended:

  The duration of 86400 SI seconds
- Contrary to public understanding of ‘time’
  - UK to carry out a public consultation in 2014
- Consequences: social, legal, religious, other?

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Alternatives to ending leap seconds

- Disseminate an unstepped time scale alongside UTC
  - TAI is preferred but could be GPS time, or another unstepped time scale
  - Critical to distinguish between the two to avoid any risk of errors
  - Essential to retain UTC (with leap seconds) as the reference for global civil timekeeping

Source: ESA

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Alternatives to ending leap seconds

- Retain leap seconds but schedule further in advance
  - 3 years achievable now
  - 10 years desirable for some applications
    - Possible if UT1-UTC tolerance increased?

- Leap seconds do have some advantages:
  - Sufficiently frequent that they cannot be ignored
  - Small enough that many users are unaffected
  - 40 years of experience

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Change of name if leap seconds ended

- UK strongly supports a new name for UTC if leap seconds are ended, eg. *temps international,* TI
  - Coordinated Universal Time no longer appropriate if UTC no longer linked to Universal Time
  - UTC without leap seconds would be fundamentally different to current UTC, identical in nature to TAI
  - Possible need for UTC with leap seconds to continue in some applications

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Summary

- UK policy has been considered 3 times at government minister level
- Proposed ending of leap seconds considered to be a radical change to civil timekeeping
- Problems due to leap seconds considered to be relatively minor, with technical solutions
- Change of name essential if leap seconds are ended
- Need to broaden debate outside the technical community and internationally
  - UK to carry out a public consultation in 2014

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