



Analysis software for land, sea, air, & space

Legislative Specifications for Coordinating with Universal Time

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Study Question ITU-R 236/7

- **Responsibility for UTC's definition historically landed with the ITU-R.**
 - The ITU-R is an administrative body chartered under the United Nations, providing regulatory recommendations
- **Study Question ITU-R 236/7 “The Future of the UTC Timescale” (2001):**
 - *“considering... that UTC is the **legal** basis for time-keeping for most countries in the world...” [asks]*
 - *What are the requirements for globally-accepted time scales for use both in **navigation and telecommunications systems**, and for **civil time-keeping**?*
 - *What are the **present and future requirements** for the tolerance limit between UTC and UT1?*

Special Rapporteur Group (SRG)

- **ITU-R WP7A Special Rapporteur Group (SRG) appointed in October 2000 to address Study Question.**
- **Early report noted legal considerations highly relevant to its decision making:**
 - ...the second meeting of the ITU-R Special Rapporteur Group met in Paris 21-22 March 2002. The Special Rapporteur Group has converged to the opinion of freezing the present difference between UTC and International Atomic Time (TAI) at the current value of 32 seconds. It was decided at the Paris meeting that it would be necessary to retain the name "Coordinated Universal Time" and the abbreviation (UTC) to avoid potential problems regarding the definition of national time scales. UTC is the legal basis for time in many countries. Consequently, many laws might have to be rewritten to account for this change.
- **Practical effect to change the basis of civil time-keeping from mean solar time and/or Earth rotation.**

What's in a name?

- **Many jurisdictions recognize Universal Time (UT) or mean solar time at Greenwich (GMT) as an explicit legal standard**
 - United Kingdom, Ireland, Canada, *etc.*
- **Only recently have some nations codified UTC**
 - provincial Australia (2005), the USA (2007), *etc.*
- **For nations legislating “UTC” for decades, should UTC be changed w/o legislative endorsements?**
 - France, Germany, the Netherlands, Switzerland, *etc.*

Legal and technical considerations may necessitate a different name.

What's mean solar time?

- **Duration of the year in terms of sidereal days**
 - 366.242 transits of the vernal equinox
 - One less solar day per year than sidereal days
- ***Mean solar time* is realized with a clock whose diurnal rate of operation exceeds the rate of sidereal time by $\sim 3^m 56^s$ (1/366.242) / sidereal day.**
 - The rates of mean solar time and mean sidereal time are thereby proportional to Earth rotation
- **Measured by observing celestial objects beyond the solar system.**
 - Historically done from fixed observatories such as the Airy transit circle at Greenwich.
 - Today, this is done with VLBI observing extra-galactic quasars.

What's mean solar time?

- **Earth-rotation angle is a everlasting and widely apparent sequentially increasing continuum**
 - rate of uniformity is far superior to most mass-produced clocks and computers in use today.
- **Today, Universal Time defined to be linearly proportional to Earth rotation angle**
 - not explicitly based on analytical Mean Sun anymore
 - constant of proportionality traceable to Newcomb's Mean Sun.

UT1 a very close approximation to the Sun's mean diurnal motion, such that the rates of *Universal Time* and *mean solar time* at Greenwich are practically equivalent in the long-term.

What's mean solar time *at Greenwich*?



- **Standard reference meridian on Earth necessary to define a global time scale based on Earth rotation**
- **International Meridian Conference of 1884:**
 - “the meridian passing through the center of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude.”
 - Mean solar time at Greenwich already commonly used
 - Many nautical charts and almanacs referenced to Greenwich meridian
- **Mean solar time at Greenwich (GMT) is legal basis for civil timekeeping of most nations now or historically.**
 - GMT acronym survives as a navigational synonym for UT1

What's mean solar time *at Greenwich*?



- In 1925, US and UK almanacs changed from “astronomical days” which began and ended at noon to “civil days” beginning and ending at midnight.
- **British *Nautical Almanac* continued to label this new convention as GMT**
 - resulted in recommended use of “Universal Time” by the IAU
- **12 h ambiguity poses no apparent issues in the context of legal statutes**
 - *Greenwich mean time* was already codified before 1925
 - It unambiguously meant civil time of day beginning and ending at midnight in legal contexts.

What's mean solar time *at Greenwich?*



Legal Time v. Official Time

- **Legal time is that prescribed by law or decree of a national sovereign authority**
 - Issues of imposition and obligation complicate if internationally recommended practice conflicts with national legality
- **Various classes of national law:**
 - *statute law* prescribed by legislatures
 - *case law* established by judicial decisions
 - *common law* expected by the general public
- **Statutes often defer details to a responsible entity**
 - *Regulation*
 - results in *official time* or *regulatory time*
 - must suppose that statutory specifications important

“requirements...for civil timekeeping?”



- **Within the context of Question ITU-R 236/7, “requirements...for civil time-keeping” presumably refers to *official time* at a national level.**
 - National governments maintain their own realizations of UTC
- **Study Question seemingly urges careful consideration of national statutes, but this viewpoint may not be shared by all who study this issue.**
 - Nelson *et al.* (2001): “should the definition of UTC be revised, the effect on legal codes may need to be investigated”
 - Afterward!
 - rationale may be that few national laws stipulate the required proximity between official time and astronomical concepts

The Leap Hour

- **Consideration of what might be legally satisfactory contributed SRG's "consensual opinion" at ITU-R *Special Colloquium on the Future of UTC* in 2003:**
 - “Serious consideration was given to a contribution proposing that the maximum tolerance of DUT1, the difference between UT1 and UTC, be increased to one hour. This alternative was based on a similar concept of daylight saving time. This modification of standard time used by nations that is determined by national civil authority appeared to satisfy all civil requirements and concerns.”
- **Recommendation does not seemingly consider:**
 - Most nations *don't* practice daylight saving time

The Leap Hour



Shaded regions where DST / summer time currently practiced

The Leap Hour

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- **Recommendation does not seemingly consider:**
 - Most nations *don't* practice daylight saving time
 - *Local clock time* and *basis time* are legally distinct
 - No legal precedent for large adjustments to basis or background time
 - No technical basis for regulatory authorities to interpret statutory specifications of UT / GMT so inaccurately

Why Does UTC = UT Legally?

- **Navigational use of “Greenwich mean time” implies UT1**
 - UT2 also basis for standard-time broadcasts for many years
 - UT1 corrected for seasonal variations of Earth rotation (measured in milliseconds).
- **Original concept for mean solar time adopted into law predates all various realizations of UT**
 - UT0, UT1, UT2, UTC...
- **UT observed, extrapolated, or reduced afterward**
 - different people may acceptably observe & reduce differently
 - technical methods also generally unspecified under law

Why Does UTC = UT Legally?

- **Law does not place rigid statutory prescriptions on the realization of Universal Time for legal purposes**
 - Technical usage provides meaning of the terms
 - One cannot definitively assign a specific realization of Universal Time within most legal contexts.
- **UTC endures as a legally acceptable proxy for Universal Time because it intends to be, and is technically useful as, a realization of Universal Time.**

UTC without leap seconds becomes a questionable proxy for Universal Time technically and therefore legally.

Standard Time in the UK

- **When *Greenwich mean time* became a legal standard across Great Britain in 1880, it had no other meaning except mean solar time at Greenwich.**
- **Today many civilian applications casually describe UTC broadcasts as “GMT”.**
- **Parliament did not specify a legal title for British Summer time (which is GMT plus one hour)**
 - results in occasional descriptions of British summer time as GMT
 - Same situation in the USA
 - the term “Daylight saving time” (DST) not codified
 - Literally the statute implies DST = “standard time”, yet everybody knows better

Standard Time in the UK

- **That GMT has become synonymous with UTC does not imply that these two concepts should be interchanged if one is not a realization of the other.**
 - The presence of leap seconds makes UTC synonymous with *Greenwich mean time*.
- **Bills attempting to replace GMT with UTC have been debated but not passed.**
 - Where UTC was not made explicitly legal, one may conclude that Earth rotation is intended as the ultimate basis for civil time.
 - Presently UK is reportedly opposed to UTC redefinition.

Standard Time in Canada

- **Canada is an example of a nation where both UTC and Greenwich mean time are simultaneously legislated**
 - Québec recognizes UTC since 2006
 - Other provinces recognize Greenwich time
 - Alberta, Manitoba, Ontario, Saskatchewan, *etc.*,
- **Legal consistency between Canadian provinces suggests a need for continued coordination of UTC and Greenwich mean time.**
 - Presently Canada is reportedly opposed to UTC redefinition.

Standard Time of the European Union

- Directives of European Parliament reconciling summer-time adjustments across the European Union is an example of parliamentary law applying to a variety of EU member nations having different legal bases for national time.
- Does the appearance of *Greenwich mean time* in translations occur because of an English language substitution of UTC in EU parliamentary law?
- Legal consistency between member countries of the European Union would seemingly require close coordination of Coordinated Universal Time and Greenwich mean time.

Standard Time of the European Union



	Language	Original Language Quotation	Translation
BG	Bulgarian	<i>по Гринич</i>	Greenwich time
EL	Greek	<i>ώρα Γκρίνουιτς</i>	Greenwich time
EN	English	Greenwich Mean Time	Greenwich mean time
ET	Estonian	<i>Greenwichi aja järgi</i>	Greenwich mean time
LT	Lithuanian	<i>nakties GMT laiku</i>	Greenwich mean time
LV	Latvian	<i>pēc Grīnvičas laika</i>	Greenwich mean time
HU	Hungarian	<i>greenwich-i idő</i>	Greenwich mean time
MT	Maltese	Greenwich Mean Time	Greenwich mean time
SK	Slovakian	<i>greenwichského času</i>	Greenwich mean time
SV	Swedish	<i>Greenwichtid</i> (Greenwich Mean Time, GMT)	Greenwich time (Greenwich Mean Time, GMT)
FI	Finnish	(GMT)	(GMT)
CS	Czech	<i>světového času (GMT)</i>	universal time (GMT)
PL	Polish	<i>czasu uniwersalnego (GMT)</i>	universal time (GMT)
ES	Spanish	<i>hora universal</i>	universal time
FR	French	<i>temps universel</i>	universal time
IT	Italian	<i>ora universale</i>	universal time
PT	Portuguese	<i>tempo universal</i>	universal time
RO	Romanian	<i> timp universal</i>	universal time
DE	German	<i>Weltzeit</i>	“world time”
NL	Dutch	<i>wereldtijd</i>	“world time”
DA	Danish	<i>verdenstid (UTC)</i>	“world time” (UTC)
SL	Slovenian	<i>univerzalnem koordinirane času (UTC)</i>	coordinated universal time (UTC)

Standard Time of All Nations

- **With mechanical time pieces, civil conventions for uniform time became related to mean solar time**
 - Acceptability of atomic time secured via leap seconds.
- **CCIR affirmed UTC was to provide Universal Time:**
 - “*considering...* the continuing need of many users for Universal Time (UT)... *unanimously recommends...* that the transmitted time scale should be adjusted when necessary in steps of exactly one second **to maintain approximate agreement with Universal Time (UT)...**”
 - “GMT may be regarded as the general equivalent to Universal Time.”

“Coordinated Universal Time” presumed coordinated with Universal Time.

Summary

- **UTC is a global regulatory time scale elevated by statute in some (not all) nations**
 - Some nations continue to (intentionally) recognize Earth rotation as their legal basis
 - “Universal Time” or mean solar time at Greenwich
 - International laws and treaties may suggest Earth rotation (UT or GMT) even if some national signatories use UTC.
- **“Coordinated Universal Time” no longer coordinated with Universal Time will be confusing**
- **National legal specifications still seemingly demand close coordination of Coordinated Universal Time and UT / Greenwich time.**



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