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1972--THE YEAR OF THE LEAP SECOND

By international agreement, a new time scale featuring "leap seconds" will go into effect January 1, 1972. The new scale will use atomic seconds, which are slightly shorter in duration than the astronomical or earth seconds now in use (prior to Jan. 1, 1972). Leap seconds, or extra seconds, will be added when needed to make the new time scale agree with time kept by the earth's rotation. For places like the National Bureau of Standards, U.S. Department of Commerce, this means setting their superbly precise clocks back a second (adding a leap second) about once a year; for people whose timepieces vary a second or more in a year, the change won't make any noticeable difference. The new scale was agreed upon by the International Radio Consultative Committee, a group in which the Bureau is represented by members of the NBS Time and Frequency Division.

The term leap second comes from analogy to our calendar system which adds another day every leap year to compensate for the fact that a year is not really 365 days but about 365 1/4 days instead. Similarly, when using atomic

seconds, a duration of 365 earth days will not really be 31,536,000 seconds but might be closer to 31,536,001 seconds instead because the rate of rotation of the earth is not constant. It happens that about once each year we may have to add (or subtract) one second to our time scale, just as we add an extra day to the calendar each fourth (leap) year.

The impending change relates to atomic clocks and the fact that the earth rotates at a slightly different average rate each year. The earth, scientists tell us, rotated about 14 percent faster 500 million years ago, for example. And, since 1958, the earth has slowed by about 10 seconds relative to atomic time. To most of us, the changes have been of no consequence. We continued to call a day 24 hours, or 1440 minutes, or 86,400 seconds and we have blissfully ignored the fact that today, the earth's "hours," "minutes," and "seconds" are slightly longer than those of ten years ago.

Until October 1967, all mankind used the earth's motion as their primary timekeeper, but not everyone was happy about it. Discontent with the earth as a primary standard of time began to stir among astronomers in the late 19th century when they first suspected that the earth's rate of rotation was not constant. To be most useful, a second of time should be the same length this year, next year, and in all the years to come. That requires disassociating the concept of time from the earth's rotation and measuring it by some constant periodic motion or phenomenon.

Atomic physicists have found such a phenomenon in the natural oscillations of atoms. The next step was to build a device to count the

incredibly rapid atomic oscillations. When they succeeded in doing this, they had an atomic clock.

The United States National Bureau of Standards built the first atomic clock in 1948, and a new era of timekeeping was born. Scientists at the Bureau and in other countries continued their experiments, building better and better atomic clocks, until they were able to keep time that was more than ten thousand times more uniform than earth time.

The highly accurate atomic second was a real help to metrologists who use the second as a basic unit when measuring frequencies. The improved measurement of frequencies resulted in improvements in many kinds of electronic devices, including television, computers, and radar. A collision avoidance system for airliners may be available in 1972 which depends on precisely syncronized clocks aboard each plane.

Not everyone shares the scientist's passion for highly uniform time scales. Navigators for ships at sea, especially, are interested in a time scale which is synchronized with the rotation of the earth, so that they can tell where they are by their angle from a star, a planet, or the sun.

The conflicting interests of scientists and navigators led to the adoption of a double standard of time in 1967 when the General Conference of Weights and Measures adopted the atomic second as the international standard for time interval. Standard time of day, known as Universal Time or UT, continued to be determined by the rotation of the earth. In order to use atomic clocks to keep the time of day, it was necessary to lengthen or "offset" each second slightly to make it correspond with the earth's rotation.

This offset-atomic time was designated as Coordinated Universal Time or UTC and is generated by the National Bureau of Standards and other laboratories so they may use their atomic clocks to keep approximate earth time.

Under the new time-keeping system to start January 1, 1972, there will be no offset of clock rates. All time will be atomic--seconds, minutes, and hours will all be of atomic-time length. Clocks will simply be reset when they get about a half second ahead or behind the earth. At the present rate of earth rotation, that will be about once a year although this will vary. This new system will still be called Coordinated Universal Time, UTC.

Stations which broadcast accurate time signals, such as the National Bureau of Standards' station WWV, will broadcast the new UTC which by virtue of leap seconds will never be more than seven-tenths of a second out of synchronization with the earth. For those few highly specialized navigators who need it, the stations will also broadcast the numerical correction currently necessary to make the broadcast time correspond with earth time. Thus, navigators can continue to use the standard time broadcasts to check their chronometers just as they have for years.

For those of us who are neither scientists nor navigators, the new atomic time scale with its leap seconds is going to make only imperceptible differences.

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