

A Genealogy of Programming Time

Behind every technology we use, there are human minds participating in the process of its creation and evolution. Just like any other modern technology, digital time can be traced back to decisions about its design, made by individuals, institutions and companies. These decisions can be attributed to actual engineers, programmers and other actors, whose contributions have played a significant role in defining the concepts of time as we know and consume it today. By Silvia Binda Heiserova.

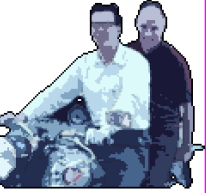
Bjarne Stroustrup



"I knew that to build the kind of distributed system I wanted, I needed language that could deal with hardware, do it well, do it efficiently, do it directly. C was a good example of that and I had Dennis Ritchie down the corridor. So if I really want to know how to do something for real in C, I know where to go" (Stroustrup, 2015).

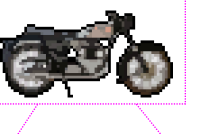
"UNIX is basically a simple operating system, but you have to be a genius to understand the simplicity."

Alistair E. Ritchie



Alistair E. Ritchie was the father of Dennis Ritchie. He worked at Bell Labs and inspired his son to join the company in the future. "I joined Bell Labs in 1967, following my father, Alistair E. Ritchie, who had a long career there. His most visible public accomplishment was as co-author of *The Design of Switching Circuits*, with W. Keister and S. Washburn; it was an influential book on switching theory and logic design just before the transistor era" (Dennis Ritchie).

BSA 650 motorcycle



The motorcycle Dennis and Alistair E. Ritchie are sitting on is the BSA 650, "a design icon of its era" according to the manufacturer. The company BSA, standing for Birmingham Small Arms Company Ltd, was founded in 1861, for the production of firearms. The brand's motorcycle division was set up in 1903, and the first motorcycle followed in 1910.

"At the time we didn't have tapes and we had a couple of file-systems running and we kept changing the origin of time. So finally we said, 'Let's pick one thing that's not going to overflow for a while: 1970 seemed to be as good as any.'"

"It turns out that 'time' is far more complicated to deal with than we usually think. For example, we have leap seconds, clocks that are not accurate and must be adjusted (possibly causing time as reported by a clock to go backward), clocks of differing precision, etc. Furthermore, language facilities for dealing with short time spans (e.g., nanoseconds) must not themselves take significant time. Consequently, the chrono facilities are not simple, but many uses of those facilities can be very simple."

C++ language

<chrono>

C++ was created by Bjarne Stroustrup at Bell Labs in 1979 as an extension to C programming language. "In <chrono>, the standard library provides facilities for dealing with time durations and time points. We often want to time things or to do things that depend on timing. The time facilities here are intended to efficiently support uses deep in the system; they do not provide convenience facilities to help you maintain your social calendar. In fact, the time facilities originated with the stringent needs of high-energy physics" (Stroustrup, 2013).

Dave Cutler



Dave Cutler was the head of the team developing Windows NT. "He played a central role in the development of Windows NT – the basis for all major versions of Windows since 1992" (microsoft.com). "The 250 members of the team aim to produce a computer program so powerful and versatile that someday everyone will need it. Standing in their way are thousands of bugs, or coding errors, and persistent doubts about the basic design of NT, which stands for 'New Technology.'" NT's most profound benefits are hidden. Its invisible acts sustain a computer much as unconscious acts—taking a breath, blinking an eye, hearing a sound—sustain a human life" (Zachary, 2014).

Windows Epoch

Windows NT represented time internally as a 64-bit integer, specifically as the number of 100-nanosecond intervals (10⁻⁷ seconds, or 0.1 microseconds) elapsed since a fixed historical starting point. This starting point was set to midnight on January 1, 1601, GMT. "I'll grant you that this isn't very useful, but the date does, after all, mark the start of a new millennium" (Richter, 1994).

Why is the Win32 epoch January 1, 1601?

Why is the Win32 epoch January 1, 1601?
The epoch used in Windows is not the same as the epoch used in Unix. It is the number of 100-nanosecond intervals since January 1, 1601, GMT. The epoch used in Unix is the number of seconds since January 1, 1970, GMT. The epoch used in Windows is the number of 100-nanosecond intervals since January 1, 1601, GMT. The epoch used in Unix is the number of seconds since January 1, 1970, GMT. The epoch used in Windows is the number of 100-nanosecond intervals since January 1, 1601, GMT. The epoch used in Unix is the number of seconds since January 1, 1970, GMT.

C language

<time.h>

C is a general-purpose programming language created by Dennis Ritchie at Bell Labs between 1969 and 1973. C was originally counting time in increments tied to hardware (e.g., PDP-11's 60Hz clock), later standardized to seconds. In C, time handling is determined by "time.h", a header file with macros, data structures and time-related functions designed for manipulating and displaying time, such as time(), localtime(), strptime(),

Ralt RT-40 race car

For many years, Cutler was racing with the Ralt RT-40 race car. "So I started racing in the Atlantic Series and I raced 56 races in that. Driving a race car is focus. What happened ten milliseconds ago, it's gone" (Cutler, 2015).

"You can't trust code that you did not totally create yourself!"

"Ideas expressed in a programming language also often reach the end users of the program – people who will never read or even know about the program, but who nevertheless are affected by it"

Dennis Ritchie



Dennis Ritchie and Ken Thompson defined "time" for the scope of the Unix Operating System. "I contributed to the Multics project, then a joint effort of Bell Labs, MIT, and General Electric. I helped with a compiler for the BCLP language on the Multics machine (GE 645) and on the GE 635 under the GEOS system. Also, I wrote the compiler for ALTRAN, a language and system for symbolic calculation. Subsequently, I aided Ken Thompson in creating the Unix operating system" (Ritchie).

Ken Thompson



Ken Thompson together with Dennis Ritchie created the Unix Operating System while working at Bell Labs. "What we wanted to preserve was not just a good environment in which to do programming, but a system around which a fellowship could form. We knew from experience that the essence of communal computing, as supplied by remote-access, time-shared machines, is not just to type programs into a terminal instead of a keypunch, but to encourage close communication" (Ritchie, 1984).

Guido van Rossum



Guido van Rossum started to work on the Python programming language in the 1980s. Python was originally written in the C language. "In Silicon Valley, the global capital of high technology and innovation, every tech company uses Python on a small or large scale." "True story: The first version of Google was written in Python" (van Rossum). Today, Python is the most used programming language worldwide. In 2020, Guido van Rossum joined Microsoft.

Python module

time.

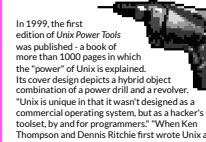
The time module provides various functions to manipulate time values. There are two standard representations of time. One is the number of seconds since the Epoch (a.k.a. GMT). In Python programming language, the epoch is the point where the time starts. It is the return value of time.gmtime(0). It is January 1, 1970, 00:00:00 (UTC) on all platforms. The other representation is a tuple of 9 integers giving local time. The functions in this module may not handle dates and times before the epoch or far in the future. The cut-off point in the future is determined by the C library, for 32-bit systems, it is typically in 2038 (docs.python.org).

Unix Epoch

```
11/23/79      11:11:01 AM  DST TIME (EST)
NAME          *1 hour - 1s.
              (Time ADJUST)
DESCRIPTION   BEGINNING OF THE TIME SCALE 00:00:00, Jan. 1, 1970, assumed as start of a second, the higher order digits are the AT register and the one order in the HD.
FILES        ---
SEE ALSO     ---
DIAGNOSTICS ---
BUGS        ---
SOURCE      ---
OWNER       ---
PERMISSIONS ---
```

In 1971, Ken Thompson and Dennis Ritchie wrote the manual for using the time command. The description of time is based on the Unix Epoch, which at that moment was set as 00:00:00, January 1, 1971. Because in programming, time is flexible, the Unix Epoch was changed in 1973 to count time in whole seconds from January 1, 1970, GMT. Currently, this is the moment when time for all Unix-based and Unix-like systems starts. These systems include Android, iOS and macOS. As of 2024, Unix-like and Unix-based systems represent a share of around 70% of all users worldwide.

Unix Power Tools



In 1999, the first edition of Unix Power Tools was published – a book of more than 1000 pages in which the "power" of Unix is explained. Its cover design depicts a hybrid object combination of a power drill and a revolver. "Unix is unique in that it wasn't designed as a commercial operating system, but as a hacker's toolset, by and for programmers." When Ken Thompson and Dennis Ritchie first wrote Unix at AT&T Bell Labs, it was for their own use and for their friends and coworkers. "If you learn Unix and its utilities from the command line, you don't have to be a programmer to do very powerful things with a few keystrokes" (Powers et al., 2003).

"Unix is not an operating system as much as it is a way of thinking" (Powers et al., 2003).

Unix command

sleep

The sleep command first appeared in Unix Fourth Edition released in 1973, with the following description: "Sleep will suspend execution for time seconds. It is used to execute a command in a certain amount of time or to execute a command every so often." It had a reported bug that the time value of sleep must be less than 65536 seconds.

"Like all other operating systems, Unix has a concept of the time. And virtually all Unix systems, even the smallest, include a clock with some sort of battery backup built in. All Unix systems keep time by counting the number of microseconds since midnight, January 1, 1970, Greenwich Mean Time" (Powers et al., 2003).

Python function

sleep()

One of the main Python functions used for handling time is called sleep. It suspends execution for the given number of seconds. According to Cambridge dictionary, to sleep means "to be in the state of rest when your eyes are closed, your body is not active, and your mind is unconscious." "Managers that compare the computer to a human brain are common in computer science and can be traced back to a fertile period of research that unfolded after the Second World War" (Wilson, 2024).