Digital Time: Latency, Real-time, and the Onlife Experience of Everyday Time

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In 1972, the first commercial digital wristwatch was released, the Hamilton Pulsar P1. The following year, James Bond wore the P2 model in *Live and Let Die*. Since then, we have been quantifying our everyday time way too accurately. I belong to the generation that has experienced the shift from being told that "it is almost 11 o'clock" to being told that "it is 10:57". Admittedly, things have improved. Today, digital watches often hide behind analog interfaces, and the clock hands of a smartwatch may restore some healthy approximation at the user interface point. And yet, the automatic system of a delivery service still warns me that the package will be delivered between 10:57 am and 11:57 am. Computers do not joke and do not round up. Of course, the courier then arrives when he can.

How has time changed due to the digital revolution over this half-century? Time is a classic philosophical topic (Callender, 2011; Baron & Miller, 2018; Power, 2021). There is the time of physics, of which Einstein speaks. There is the time of metaphysics, of which Heidegger speaks. And there is the time of daily experience, that of the courier, of me, waiting for him, and of which Ecclesiastes ("Kohelet" or "Qoheleth") speaks in the *Bible*, when he reminds us that "There is a time for everything, and a season for every activity under the heavens" (Ecclesiastes 3:1), even for Amazon parcels. It is this experiential, everyday time that digital technologies are transforming profoundly. The story started a long time ago.

For millennia, we have used space to quantify and structure time, moving from an approximate word to a universe of increasingly accurate measurements (Koyré, 1957). The shadow of the obelisks and sundials, the flow of water or sand in the hourglasses, and the oscillation of the pendulum or of the balance wheel with return spring in mechanical clocks are all systems that use space to measure the duration of time (*how long*: the train arrives at its destination an hour after departure), establish when things happen (*when*: the train leaves at 10:30), and compare or synchronise events (*while*: I will meet you at the railway the station while you are there). The continuity of time was soon organised through the continuity of space, which in turn

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was quantified using the sexagesimal system (ratio 1/60 between units of measurement and its submultiple); think of the hour, minutes and seconds (Holford-Strevens, 2005). Today we are so used to treating time as space and this kind of spacialised time as a numerical quantity that we often fail to distinguish between the experience and the measurement of time, marvelling that the same time spent on the train lasted a moment for Alice but an eternity for Bob. So far, nothing new; one may just read Bergson.[1] Things began to get complicated with the arrival of digital technologies.

For over half a century, the digital has been transforming (re-ontologising) the relationship between space and time by modifying a third variable: the speed of the processes of *communication* (both in the sense of *interacting* and in the sense of *transferring*) and *manipulation* (transforming) of something.

The trend was already underway in modern times when the evolution of transport rendered distances ever shorter and thus made it more and more natural to think of space in terms of travel times. Once one can travel around the world in 80 days,[2] it becomes increasingly more intuitive to reverse the relationship and use time to measure space. Today it is the ETA (estimated time of arrival) that counts, not how many kilometres away Alice lives from downtown, for example. Or think of the "15-min city", which defines urban space based on the time required to reach essential services on foot or by bicycle (Moreno et al., 2021). In all this, the digital is still part of a modern trend, amplifying it, but not in ways that need to be considered unprecedented. The real novelty is that our digital culture has introduced one of the most interesting and influential concepts today to understand the humble time of everyday experience, that of *latency*.

Latency is different from bandwidth, even if both refer to speed. Bandwidth refers to the speed of a connection, and it measures how much data can be transferred between two points of a network in a specified time. In terms of everyday experience, it is the time it takes to download a file on the internet, for example, or stream a movie. Latency is also a matter of speed, but it refers to the time (sometimes called delay) that occurs between a cause (usually a user's action) and its effect (usually the response to a user's action), so not to how much data one can transfer but how quickly one can interact with something. For example, there may be a long latency between clicking on a web page and the webpage reacting accordingly, depending on many variables, including the connection's speed, but overall, that is a matter of latency. Likewise, the latency between pressing a key on the keyboard and seeing the letter appear on the screen is usually less than 40 ms (ms), if it is a good keyboard.

Latency combines the concepts of *communication* (how long it takes for a signal to arrive at its destination and return to its starting point) and *interaction* (the return of the signal indicates the possible change produced by the signal) with that of *causality* at a distance: Alice does something here to change something there, while

[1] Originally *Essai sur les données immédiates de la conscience*, Bergson's doctoral thesis, first published in 1889, see now (Bergson, 2014).

[2] Originally *Le tour du monde en quatre-vingts jours*, by Jules Verne, first published in 1872, see now (Verne, 1995).

perceiving the change. High latency means a slow time of interaction; low latency is just the opposite.

In a way that is only apparently paradoxical, we are organisms that are well-adapted to a given range of latency. Above very high and below very low latency, we no longer perceive any change or interaction. If a web page takes minutes or even longer to change when we interact with it, we may think it is simply "frozen". That is why Operating Systems have various ways of indicating that an app is still busy. Apple calls it officially the "spinning wait cursor"; Microsoft prefers "Windows wait cursor". In a Wittgensteinian move, one may be tempted to speculate about the family resemblance between "cursor" and "curse". All this is relatively intuitive. Raise the latency, and the world slowly grinds to a halt: for all you know, the touchscreen with which you interact may be made of marble.

Less intuitive is what happens when the latency of a signal becomes increasingly low. Imagine Alice bouncing a tennis ball against a wall. Its "latency", so to speak (how long it takes to come back), is sufficiently high and such that Alice can easily catch the ball when it returns. Now let us imagine that the ball makes the round trip more and more quickly, that is, with lower and lower latency. There will be a moment when it will be difficult for Alice to catch the ball because it returns to her in ever shorter times. However, at some point, if the speed increases further, it will become very easy to "catch it" because she will not be able to make the ball leave her hand, as it were, or to be more precise, it will become impossible for Alice to experience the ball leaving her hand, given that the ball will return to her in a few milliseconds. This is what happens when we play online: it seems that "we are there" (telepresence) because our sensory apparatus perceives interactions below 100 ms of latency as immediate, in the etymological sense of not mediated by anything else (and this is why serious video-gamers choose their keyboards very carefully, as well as their displays[3]). It is called "real-time", that is, time (sometimes only apparently) not mediated. The concept deserves some explanation.

"Real-time" is a technical expression coined in the forties to discuss the design of "electronic digital computers", as they were called at the time. Apparently, the first recorded usage was in 1946 by John Eckert, who, with John Mauchly, designed the first general-purpose electronic digital computer (ENIAC) and later the first commercial computer in the U.S. (UNIVAC).[4] After that, "real-time computing" became a technical expression to refer to any computation that is constrained by some time limit, so that it must provide an outcome within a "deadline". However, the more general concept of "real-time" now refers to something (an event, a process, etc.) that is simulated, represented, communicated, interacted with, shown etc., *at the same time* or *at the same rate* as it happens. The distinction is essential. Real-time

[3] Video-gamers are interested in "frame rates" or "frames per second" (fps) because better graphics cards and better monitors, with higher fps, provide a competitive advantage. Standard monitors are usually 60 Hz (capable of displaying 60fps), but 120 Hz, 144 Hz, and 240 Hz monitors are also available, with 120 Hz displays availabel also for some mobile phones. Many thanks to Prathm Juneja for this note. See also https://www.wepc.com/gaming-monitor/compare/60hz-120hz-144hz-240hz/

[4] See now (Williams & Campbell-Kelly, 1985).

news about an event, for example, is news that arrives at the same time as the event reported unfolds, without any delay. Likewise, so-called nowcasting is a kind of short-term forecasting that monitors something (often meteorological or economic conditions or events) in real-time. However, a real-time movie is not a CCTV camera monitoring a bank, but a film that records an event, like a 5-min walk, precisely as (not when) it occurs, without any edits or jumps, lasting the same amount of time. It is this latter, more narrative meaning on which I wish to concentrate.

If the latency of an interaction is low enough, a surgeon can operate thousands of miles away by controlling a robot in real-time, feeling like she is in the operating room, interacting *at the same time* and *at the same rate* at which events unfold. It is the transformation brought about by 5G, which has a latency of 10 to 30 ms (that of 4G is about 50 ms). Low latency and high-speed translate not only into telepresence — it no longer matters where one is located physically to be able to interact as if one were present elsewhere — but also in faster travel times of increasingly heavier tennis balls, to continue with the previous analogy. At high speeds and very low latency, it becomes less and less important how many bits have to be transferred. It is this combination that makes autonomous vehicles possible.

In the infosphere, latency determines real-time experiences, and it is a significant measure of the space in which we live. Too high latency means living in the suburbs, distant or even detached from the rest of the infosphere, and very low latency (everything immediately — i.e. in real-time — interactable) means living at the centre of the infosphere (telepresence). Zero-latency everywhere is the definition of omnipresence. Bad latency means feeling sick while immersed in a virtual reality environment.

Consider next the speed at which something can be manipulated. I am aware that computer scientists do not speak precisely this way, but, philosophically, this too can be interpreted as a matter of latency, in this case relating to the time it takes to transform data into information (latency between input and output in a simulation is also called transport delay). When Turing needed to decrypt the secret messages of the German army, one of the main problems was time. It is useless to decrypt a message when the event to which it refers has already occurred, in precisely the same sense in which it is useless to work 72 h to predict the weather for the next day. The solution was Colossus (Copeland, 2006), the computer that Turing helped design, capable of processing up to 100,000 instructions per second (IPS). Finally, messages could be read before the events to which they referred had happened. Today, an ordinary PC with a Ryzen-type processor, manufactured by AMD, completes 2,356,230 million instructions per second (MIPS). It "render[s] time irrelevant", as AMD's advertisement puts it.[5] It is only with this low "latency" between inputs and outputs that Artificial Intelligence can work, often better than us, for example, when reaction times must be immediate (in the sense of non-mediated, i.e. in real-time, as we have seen above), just think of algorithmic trading in capital markets (Floridi, 2019, 2020). The availability of quantum computing will be another leap in the history of latency, making possible calculations, simulations, and interactions that would otherwise be

[5] https://subscriptions.amd.com/newsletters/commercialchannelnews/archives/2019_11_en.html

unfeasible in reasonable spans of time. As early as 2019, Google's quantum computer was 158 million times faster than the fastest of classic supercomputers.[6] The future belongs to those who can simulate it. This is not the place to elaborate on this remark, but quantum computing will be the return of the crucial role of space (think of quantum superposition and entanglement) to determine time.

Digital technologies are technologies of "unreal-time", that is, of time that is *mediated* by the technology itself. However, this digital unreal-time may be experienced as "real-time" because the mediation can reach a latency so low that what is mediated may be experienced as immediate. So, it is unreal-time de facto, which is not unreal but real *de experientia*. Following Amazon's example when it speaks of "Artificial, Artificial Intelligence",[7] that is, AI that is not really AI because real people are involved, digital time may then be described as "unreal, unreal-time", that is, time which is mediated in such a way as to be perceived as immediate and therefore real. It is this kind of time that enables us to be present and interact at a distance (telepresence), do more things simultaneously (multitasking), transform more and more data into the information we want, simulate what is possible, and anticipate what may happen. This is why the experience of time is changing for anyone living "onlife" (Floridi, 2014b).

Digital technologies create and shape our environments, the infosphere, where we spend increasingly more time (Floridi, 2014a). And because the infosphere is not entirely "natural" but also artificial and hence designed and managed by human beings for other human beings, we need to reflect much more on its nature and dynamics, to make sure it is designed to be equitable and sustainable (Floridi, forthcoming, 2013), to manage as well as we can "the new speed of politics and the new politics of speed", as Josh Cowls put it,[8] and to understand how we want to save the time we have (think of the job market), how we want to improve it (think of public and individual health), how we want to use it (think of entertainment), and how we want to distribute it (think of time management). We also need to know more and regulate better those who control the "unreal, unreal-time" of our lives. We must proceed quickly, because *Tempus fugit* and there is no time to waste, but with caution, because these are fundamental issues that we must get right. *Festina Lente*, as the Romans used to say.[9]

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6 https://www.forbes.com/sites/chuckbrooks/2021/03/21/the-emerging-paths-of-quantum-computing/?sh=150799356613

7 https://www.economist.com/technology-quarterly/2006/06/10/artificial-artificial-intelligence

8 https://medium.com/josh-cowls/flattening-the-curve-forwards-the-new-speed-of-politics-and-the-new-politics-of-speed-3f19c1fad8ee

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