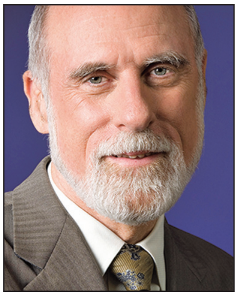

Instrument Thyself!

Vinton G. Cerf • *Google*

Much has already been written about the "quantified self" or terms similar in intent. The idea is to instrument our bodies on a more-or-less continuous basis so as to not only establish a baseline of normal, measureable behavior but also use this information to detect potentially serious variations from the norm that might have fatal consequences.

Such initiatives have several interesting side-effects. The first is to reveal how we actually spend our time and exercise our bodies in the course of daily events. Our recollections rarely coincide precisely with the measurements we are now capable of making. Second, the aggregation of such information could let us see trends in a population that might have important implications for public health. Third, the pursuit of quantification could lead to new, noninvasive methods for capturing vital information.

Google's recent announcement of its work on a "smart contact lens" illustrates some of the potential for these technologies (www.businessinsider.com/google-x-smart-contact-lens-2014-1). The smart contact lens samples minute quantities of fluid in the eye (that is, tears) to measure and estimate the level of glucose in the blood stream. That this is of vital interest to type 1 diabetics (juvenile onset) is obvious. It's a technological breakthrough of significant proportions. Although it isn't yet either operational or approved by the US Food and Drug Administration, it demonstrates the possibilities of miniaturization and biological measurement that will inform new developments in the future.

Among the more interesting features of the Google design is the delivery of power via RF signals. Wireless power isn't a new topic, but the safe delivery of sufficient power for this purpose is a nontrivial accomplishment. What's also interesting is the possibility that other instrumentation that is on or embedded in the body might be controlled and information extracted by similar means. The famous X-Prize Foundation has a US$10 million prize, sponsored by Qualcomm, for the design and construction of a working "tricorder" — an instrument made popular in the Star Trek science fiction television series of the 1960s. It seems reasonable to anticipate that over the next decades, we will see such devices in common use.

Capturing such important information has privacy and safety concerns that are worth calling to mind. Clearly, such data must be kept private if it's associated with a specific individual. But we might still like to aggregate such information to form a common understanding of a population's state of health. It's also clear that the integrity of the collected data is vital, especially if this information is used to diagnose and prescribe treatment for serious health conditions. Surreptitious or malicious modification of measured health data could easily lead to incorrect diagnosis or treatment with potentially fatal consequences. We're led, quickly, to the need to digitally sign the collected information in a way that makes it very unlikely to be forged or corrupted in an undetectable way.

At the microscopic level, we can imagine that the effectiveness of targeted drugs might be assessed at the level of cells comprising cancer tumors or infection sites. Such close monitoring of treatment progress would be unprecedented in the practice of medicine.

We might also imagine that nanotechnology and biologically inspired nanostructures have a role in aiding the development of such instruments. Flexible electronics, extremely low-power radio communication, microfluidics, and other technologies will have a part to play in this space. It's also intriguing to imagine that self-organizing structures could also find utility if the monitoring devices must be produced in the countless trillions to be effective.

 1089-7801/14/$31.00 © 2014 IEEE

We've already seen that mobile platforms are becoming key components in this kind of self-monitoring and also the means by which appropriate parties can receive alerts should there be indications of serious health problems. Examples include an artificial pancreas that can monitor blood-glucose levels and manage directly the influx of insulin into the body. The Internet has a remarkable potential role to play in facilitating this kind of observation and an equally daunting responsibility to protect the privacy and integrity of the data collected.

It seems clear that the engineers, scientists, and practitioners who are leading us toward these truly remarkable goals must also bear in mind the potential hazards these technologies pose and incorporate into their designs the means to mitigate the risks and let us all reap the benefits.

Vinton G. Cerf is vice president and chief Internet evangelist at Google, and president of ACM. Contact him at vint@google.com.