

Smartwatches: assumptions and outlook

While the arrival of connected watches may be game-changing for some, others see it as a great opportunity to expand their market. Whatever your viewpoint, smartwatches are certainly a talking point, raising doubts and hopes in equal measure. Rather than fear that history will repeat itself and another crisis is looming for the watchmaking industry – like the one we were told to expect after quartz watches appeared in the 1970s – it's worth remembering this: Switzerland has been in possession of similar products for many years already, and has the technology essential for producing the smartwatch of the future.

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“The arrival of the connected watch will impact all watchmaking brands”, according to the specialist in the field, the Smartwatch group, which estimates that the smartwatch market will increase from \$1.3 billion in 2014 to \$117 billion by 2020. While some welcome the prospect of such significant growth with new customers *and* new applications, certain brands are having sleepless nights worrying about their market share.

The first thing to grasp about the emergence of so-called intelligent watches is that it entails an entire ecosystem that's far broader than the traditional field of watchmaking. This ecosystem is made up of players working in more or less fluid networks to bring new knowledge from vastly different horizons to one interdisciplinary crossroads. To make a place for yourself in this ecosystem, you need to have access to cutting-edge skills in electronics, medicine, power management, IT, telecoms and big data processing – and that's just for starters. Those who don't have all that know-how themselves have to engage specialists in each discipline, and may rapidly find themselves running a complex set-up – especially if it involves a network of experts. The good news is that all these skills are available in a multidisciplinary form here in Switzerland, at the CSEM, a technological research centre dedicated to industrial transfer and to developing competitive advantages for the country's industry. CSEM was created when several watchmaking research laboratories merged in 1984, and it has continued developing its technological expertise in various fields of application, including microelectronics, medicine and power management. By making the most of these assets, the watchmaking industry can

be part of this formidably fast-moving sector. Here the CSEM presents an overview of the technology required to create connected watches and sets out its view of how this market will develop.

Low power microelectronics

The origins of the Swiss electronic watch can be traced back to the Centre Electronique Horloger (CEH)¹, which was set up in 1962 when the manufactures of the era joined forces with the aim of developing a Swiss-made quartz wristwatch. Five years later, having resolved numerous issues that some naysayers had judged insurmountable, the team was ready to demonstrate its quartz watch Beta-2 in 1967. At the same time, in a first for Switzerland, an ultra-modern technology was imported from the United States: the manufacture of integrated circuits known as “chips”, which would go on to be heavily used in other applications. It was clear right from that first chip that *very low power* was the key to success, as they needed to make one single battery last a whole year. The *low power* integrated circuit was born, soon to become part of the region's overall microelectronics culture – witness, for example, the foundation of EM Microelectronics Marin in 1975.

Soon after, the need was felt to offer more functions than simply a time display. The emergence in 1982 of microprocessors for watches, like CoolRisc, enabled this development without impairing battery life. More than 30 years on and tens of millions of chips later, the CoolRisc is still integrated in new products – testimony to the enduring nature of the work accomplished.

¹ Integrated later at CSEM

As a result, the region enjoys an ultra-low energy culture that's unique in the world, having now for instance developed digital circuits that operate "below the threshold" and require ten times less power to process a calculation. With all these specialised skills and unique micropower electronics technology available locally, the Swiss watchmaking industry is well positioned to establish a differentiated platform for making intelligent watches in Switzerland.



Beta-1 quartz watch



CoolRisc Processor

Wireless data transmission

An intelligent watch is worthless without connectivity. Its interface is too impractical for the user to be able to interact effectively with the data it holds. In addition, the value of data gathered locally is only optimised when it's combined with other data available online (in the cloud) or held in huge databases (part of the big data phenomenon).

About 20 years ago, CSEM and EPFL – both in Switzerland – began researching the ultra-low power radio frequency integrated circuits that enable this connectivity. CSEM has built on this heritage to become a leading developer of the Bluetooth Low Energy transceivers that enable watches to communicate with smartphones and other tablets. CSEM is also integrating Ultra Wide Band technology in products so they can be accurately tracked, while the related algorithms and communication protocols are being refined in order to further reduce power consumption. First-rate expertise is also available in the complementary fields of wave propagation and the design of small antennas. This technology has also spread to surrounding businesses. For instance, EM Microelectronics Marin manufactures Bluetooth chips and near field communication (NFC) circuits suitable for connected products. Elsewhere, Semtech recently introduced its LoRa™ range that enables communication for months or years at a neighbourhood or town scale, using a battery.

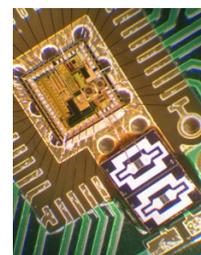
It's also worth noting that the smartwatch currently dominating the market is a peripheral device to a wireless phone, itself a bridge to the Internet – so without a phone, it's virtually useless. Meanwhile, there are other possible models that it

would be interesting to explore as a first step to capitalising on them via a connected platform in Switzerland. Watches could provide a secure means of gathering data from other sensors located around the body (e.g. intelligent plasters, connected shoes or implants). Watches could also have the capacity to connect to the internet independently via the many Wi-Fi networks available, to transmit data remotely through a network like LoRa™, or even to communicate directly with other nearby watches to create a sort of decentralised social network.

Designers in the Jura region have developed products to further connectivity and their wide experience in the field promises more innovative solutions for connected watches in the future.



icyTRX BTLE transceiver



2.4 GHz receiver

Digital healthcare

Among current trends is the rise of personalised healthcare, with medical monitoring and data being uploaded to shared networks. Vital parameters can be tracked in real time via portable devices such as smartwatches and transmitted to a doctor or medical service, or simply analysed by a special programme within the smartphone. However, connected watches are still of limited use for digital health applications and medical care, because of the inaccuracy and unreliability of measuring vital parameters with non-invasive methods. New approaches to monitoring vital parameters are constantly required, as well as skills in physiology, metrology, ergonomics, low power electronics, built-in computing, signal processing and IT (eHealth). These are the keys to successfully delivering personalised medical care.

CSEM has been involved in the field of wearable healthcare technologies for over 20 years, gradually building up an international reputation and a solid portfolio of patents in the measurement of physiological signs through wearable devices. CSEM's research has centred on reducing sensitivity to disruptive movements, extreme miniaturisation, combining signals and processing them multi-dimensionally, ergonomics and how to position sensors discreetly and comfortably on the body – expertise that is highly applicable to connected watches and their applications to personalised healthcare.

The evolution of smartphones and cloud computing, along with recent developments in fitness bands, have speeded up the appearance on the market of connected watches offering “quantified self” applications. Athletes clearly benefit from managing their physical condition and optimising performance through measuring their physiological data. Hence the success of sports watches from brands like Polar, Garmin, Suunto and PulseOn over the last few decades. Around 17 million sports watches were sold in 2014 and by 2017 there will be almost 30 million units on the market including activity trackers, totalling an estimated market value of more than \$3 billion. And the microelectronics giants are set to incorporate these digital health functions into their products in order to break into the medical market in the near future. In addition to monitoring and diagnostics, new applications like telemedicine, rehabilitation and home care – especially for elderly people – will soon take on increased importance. It's also very important for the Swiss pharmacological industry to be able to track volunteers who are participating in trials for new medicines. With its strong tradition of microtechnology and microelectronics, its flourishing medtech industry, its prestigious universities and its dynamic university hospitals, Switzerland is in a very good position to meet the future challenges of digital healthcare.



PulseON sports watch

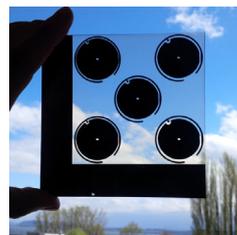


Swiss-made iFIT smartwatch

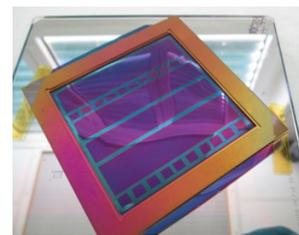
Power management

The new functions of connected watches and other wrist-worn wearables are turning out to be particularly demanding in terms of power. Generations of watchmakers strived to increase the power reserve of traditional watches, but their achievements pale into insignificance in the face of these new devices that need recharging daily. The new connected bracelets and intelligent watches will require a power source on hand, as the mechanical power available is too weak to fulfil their power requirements. Alternatives are being developed, like harvesting energy from the difference in temperature between the wearer's skin and the ambient air (TEG). This remains an unconvincing option, because the strap must be worn tight, causing an unpleasant cold sensation.

Photovoltaic energy – transforming light into electricity – seems a more likely candidate, since a large amount of energy is available outdoors to power the functions of connected watches. Indoors, CSEM's technology offers excellent yields that can cover consumption without impacting on the comfort of the wearer. This photovoltaic technology comes in both flexible and rigid forms that can be elegantly and invisibly integrated into the watch straps and dials of the future.



Flexible PV module



OPV module

Display technology

The display on a watch must be easy to read under any lighting conditions, while consuming as little power as possible in order to extend battery life. There are two types of display technology – one transmissive and the other reflective – that can also be used in combination. Displays in reflective mode use very little energy, while their consumption level when in transmissive mode depends on the backlighting. There are also mixed LCD-OLED displays that can offer a user-friendly interface – especially for tactile screens – by using intelligent energy management.

Some displays only need power when they're transitioning between states, while others draw constant power. To satisfy the varying needs, manufacturers can choose between electrophoretic (e-ink) reflective displays, OLED displays that are so power-hungry they cannot be used for continual displays, low energy reflective interferometric colour modular displays, and lastly LCD screens. These options all need to be explored so users can be offered the best balance possible balance between visibility and power consumption. And Swiss experts have all the skills necessary.



Electrophoretic displays



Reflective interferometric modular displays

Aesthetics and visual attributes

While Swiss watches must demonstrate their technical credentials by meeting exacting quality standards, they also have to display high-end aesthetics and an original, elegant design that incorporates noble materials and refined visual attributes. This is one of the key selling points for Swiss watchmakers – they have near-perfect mastery of the constituents that make a watch look like a watch, not a miniature computer worn on the wrist. Maintaining this unique expertise and finding a way of transferring this competitive advantage to the realm of connected watches will prove crucial challenges if the industry is to maintain its unrivalled balance of quality, tradition and innovation.

Big data

Data gathered by a watch and its associated sensors is often made available to the user through a web page. That way, they can track their performance, their health or their movements. The data collected is intended to help improve the wearer's health. It is also of great interest to insurers, and the manufacturer will quickly be tempted to take advantage of the data by selling it. Manufacturers are promoting the use of servers in the cloud, but this opens up serious questions about confidentiality. The answer is to draw up open standards that allow data to be encrypted.

Making available large quantities of data – harvested from a huge range of sources and constantly updated – also paves the way for large-scale analyses that enable trends to be tracked, risks and opportunities in economic activities to be identified, and also the monitoring of global problems in areas including health, agriculture and climate. This field of big data opens up huge possibilities and giving access to data generated by connected watches can be truly beneficial, but the

owner's anonymity must be protected – and the appropriate technology to achieve this does exist.

Beyond security and privacy issues, big data analysts also face extreme variability in the data, which can show momentary inconsistencies and wide variations in quality. The accuracy of data can even be cast into doubt due to errors of geographical positioning or dating. It is therefore essential that the initial measuring and subsequent processing should enable the quality of the data to be determined. This calls for good sensors, validated processing and fit-for-purpose representations.

Conclusion

CSEM has worked in the field of wearable technology for more than 20 years, perfecting the essential technological building blocks needed for connected watches. CSEM's research projects in microelectronics, microsystems and systems were instrumental in developing the existing low energy, Wi-Fi, embedded and wrist-worn technology. Cloud computing paved the way for a whole generation of connected objects, while ultra-low energy and wireless applications and communication circuits brought us nearer the emergence of connected watches.

Switzerland tops various global rankings devoted to innovation and holds all the right technological cards to maintain its leading position. Its value-added chain – ranging from academia to industry and taking in successful technology transfer along the way – works perfectly, in contrast to the situation at the time of the quartz crisis in the early 1970s. Today's market is very active and professional, involving a large number of players who keep launching innovations and demonstrate on a daily basis that watchmakers are not the spectators but very much the actors in this scenario of change.

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