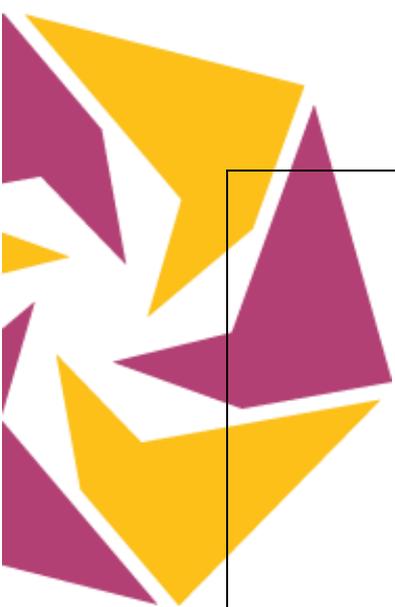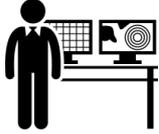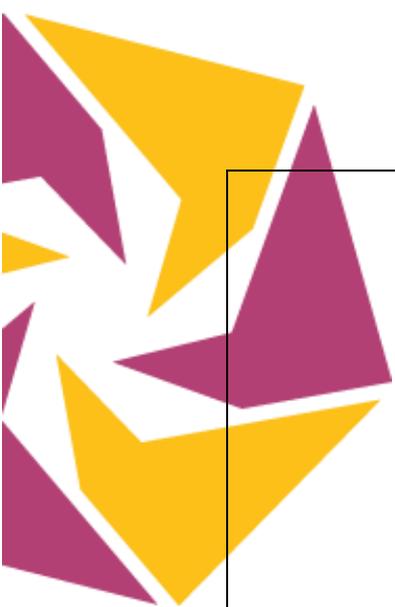# Roadmap for wearables

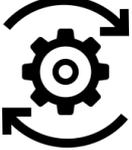| Description and state of the art | |
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| **Definition** | Wearable technology is an extension of ubiquitous computing. It is based on the advances of mobile and wireless interfacing and networking, and in particular WPAN and WBAN specifications.<br><br>*Wearables* (wearable computers and interfaces) are miniature electronic devices that are designed to be "worn" by humans, such as a wrist-mounted screen or head mounted display, to enable mobility and hands-free/eyes-free activities[202].<br><br>Wearable computers are especially useful for applications that require more complex computational support, such as accelerometers or gyroscopes, than just hardware coded logic. One common feature of wearable computers is their persistence of activity. There is constant interaction between the wearable and user, so there is no need to turn the device on or off. Another feature is the ability to multi-task. When using a wearable computer, there is no need to stop what one is doing to use the device; its functionality blends seamlessly into all other user actions. These devices can be used by the wearer to act as a prosthetic. It may therefore be an extension of the user's mind or body[203]. |
| **Addressed societal /business or public sector need** | Societal need:<br><br>Inclusive well-being and health |
| **Existing solutions /applications /services** | "The future use of wearable by health and wellbeing users, […] will create ecosystem for the population that will be adapted to their changing needs along lifespan in health and disease"[204].<br>Examples of applications/products are:<br>• Apple iOS 8 HealthKit[205]: Consolidates health data from iPhone, Apple Watch, and third-party apps and presents an overview of health related data to the user of an iPhone.<br>• Live!y[206]: Lively gives family members insight when a loved one may need their help. |

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| | • BodyGuardian[207]: wearable monitors that accommodates patient mobility, enhances compliance and streamlines data collection.<br>• Alarm.com[208]: Solution for independent living of elderly.<br>• ActiveProtective[209]: Hip protection for older adults using wearable airbags.<br>• VitalConnect Band Aid[210]: wearables to check health vitals).<br>• Medical Wearable Solutions Eyeforcer[211].<br>• Rooti Labs Limited W/Me2[212].<br>• Cardio family of products[213].<br>• Biovotion AG monitoring platform[214]. |
| Main actors regarding R&D of this technology | • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V.<br>• Commissariat a l'Energie Atomique et aux Energies Alternatives<br>• University Of Surrey<br>• Atos Spain Sa<br>• Institut National de Recherche en Informatique et en Automatique |
| Current research activities | In total there are 184 projects related to 'wearables'. Projects in which wearables play the main role and touch upon the need for inclusive well-being and health are:<br>• **I-SEE** ("Intelligent Sensor Enabled Eyewear"), with the goal to develop and launch in the market a new eyewear product line and a platform of services, focused on improving the health care and wellbeing of eyeglasses wearers, by monitoring the viewing and living experience of the consumers and allowing eyeglasses to interact with smartphones, in-car telematics and professional devices of practitioners and opticians[215].<br>• **WEAKID** ("Clinical validation of miniature wearable dialysis machine"), with the goal to validate a miniature wearable dialysis machine in a clinical setting and to prepare the system for CE-marking[216].<br>• **NIGHTINGALE**, with the goal to capture and communicate patient data in real time so that relevant clinicians are immediately aware of important risk factors and have early warning of actual deterioration to enable a rapid response[217].<br>• **MONILET** (Monitoring Bracelet for Health Use), with the objective to further develop and take to market the prototype of the wearable bracelet and cloud based IT platform for 24/7 continuous medical supervision[218].<br>• **HF-PREDICT**, on the development and validation of the first clinically accurate wearable device and machine learning software for predicting Heart Failure |

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| | (HF) of a patient[187]<br>• **ELVIRA**, concerning a unique neurorehabilitation device, integrating immersive virtual reality and neurophysiological signals into a wearable headset maximizing independent practice and objective measurement for motor rehabilitation in hospital and home settings after a brain injury or stroke[219].<br>• **SensMotion**, on the development of a wearable sensor system for selective diagnostics of skeletal muscles and motion monitoring[220].<br>• **PersRadSens**[221], impelementing a personal wearable radon monitor connected to the cloud via smart-phone, tracking the radon exposure during one's whereabouts.<br>• **Respiratory Blood Gas**, implementing non-invasive, wearable wireless blood gas and respiratory monitoring system[222]. |
| Impact assessment | **Public sector modernization:**<br>• Efficiency / Productivity<br>• Quality of Services Provided<br>**Public Sector as an Innovation Driver:**<br>• Entrepreneurship<br>• Innovation<br>• Prosperity & Well-being<br>• Quality of Health<br>• Equity & Inclusiveness<br>• Privacy & Security |
| **Necessary technological modifications** | |
| Potential use cases | Potential use cases involve any device or application that collects healthy aging data, mental data and social data and concern:<br>• Sensory integration (helping people see better or understand the world better)<br>• Health care monitoring systems |
| Technological challenges | One of the major challenges with regard to wearables is the high power consumption. Most wearable devices use wireless networks, GPS, and other technologies that consume a lot of power. Currently, the battery power of wearable devices lasts for one to two days. In the case of intensive usage, the battery lasts for less than a day[223].<br>Another major challenge is the design constraints of wearable devices, which are yet focused on technology rather than on design, and are thus bulkier, as aesthetic sacrifices need to be made for the sake of functionality.<br>Heat and precipitation can further damage wearable devices, and are thus additional challenges affecting their quality and reliability. |
| **Necessary activities (in or for the public sector)** | |

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| Development of a specific training necessary | 🟩 | No specific training is necessary. |
| Advanced or adapted ICT infrastructure needed | **Open task** | Novel interfaces for new types of wearables needed, alongside with novel APIs and gateways. |
| Change of (public sector internal) processes necessary | 🟩 | No change of public sector internal processes is necessary. |
| Promotion / information of stakeholders necessary | 🟩 | No promotion / provision of information to stakeholders is needed. |
| Need to deal with cyber security issues | **Open task** | The use of the specific technology is accompanied by the risk of hacking and thus misusing wearable devices and thereby the biometric, physiological or health data they contain. |
| New or modified legislative framework or regulations necessary | **Open task** | Adaptations in the legal framework are required to safeguard the privacy of end-users, as wearable devices are able to store a large amount sensitive data (biometric/ physiologic/health data), whereas they use GPS navigation systems to receive location-based information. |

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| Development of a common standard necessary | **Open task** | Standards on wearable technologies are still absent, alongside with absemnce at large of standardised descriptions of the artefacts they measure (such as activity). |
| Need for a more economical solution | **Open task** | The high cost of smart wearable devices is one of the major challenges, curtailing the growth of the relevant market. It is a fact that most manufacturers in this market are launching their products in the premium product category.<br>For instance, the average selling price (ASP) of a smart wearable device is US$350-380, depending on the application. The ASP of healthcare wearable devices is US$720-750, while the ASP of fitness and lifestyle products is US$280-350. In addition, the prices of branded products are very high[223]. |
| **Dealing with challenges** | | |
| Ethical issues | **Open task** | Ethical Issues arise, as wearables track various activities and personal data of their owners. |
| Societal issues | ▢ | No societal issues identified. |
| Health issues | ▢ | No health issues identified. |
| Public acceptance | **Open task** | The technology is likely to encounter problems regarding public acceptance, as wearable devices seem to be awkward for some, whereas there is a general lack of affordability. |

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