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Responder Technology Alert (April 2015)

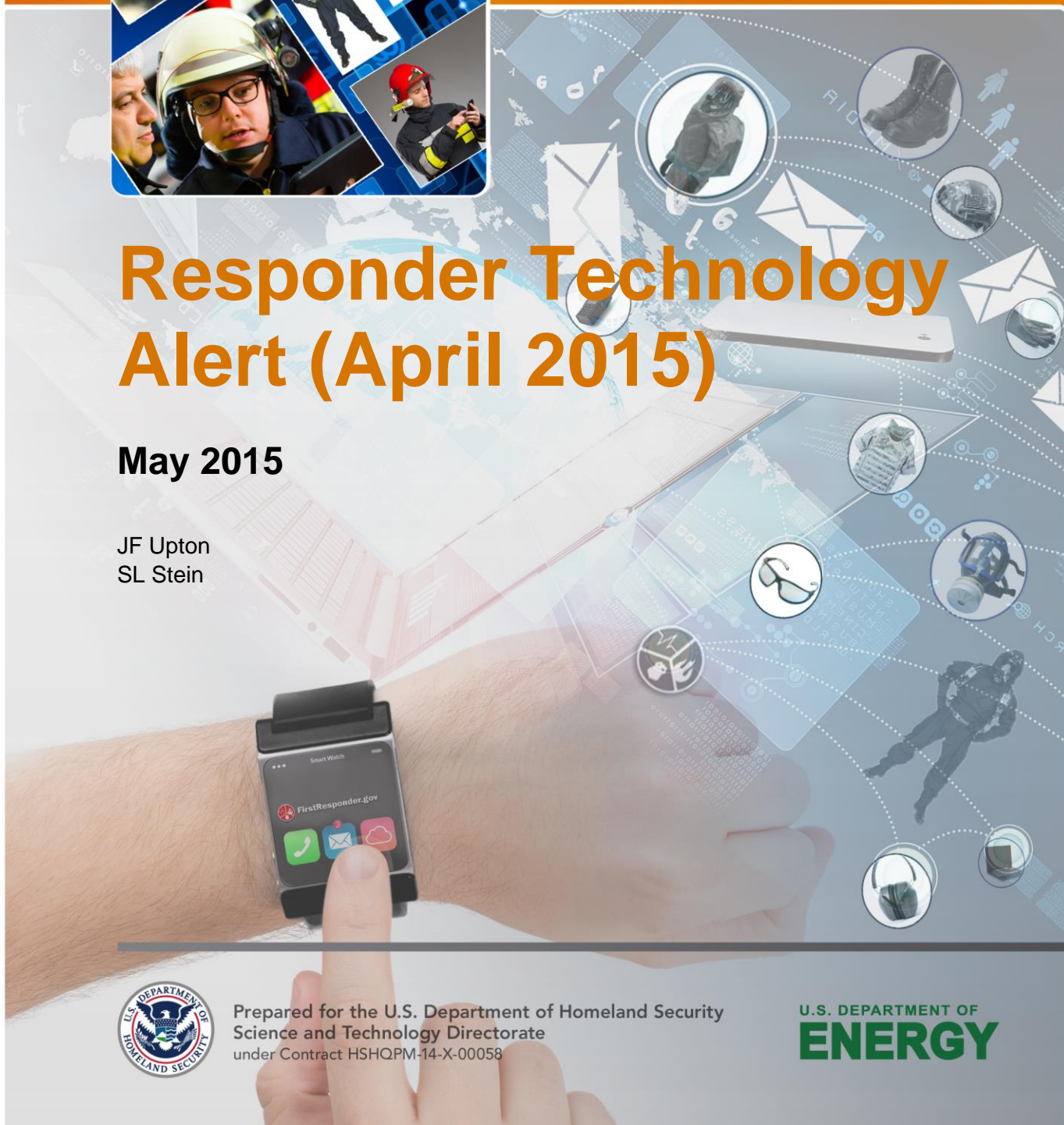
May 2015

JF Upton
SL Stein



Prepared for the U.S. Department of Homeland Security
Science and Technology Directorate
under Contract HSHQPM-14-X-00058

U.S. DEPARTMENT OF
ENERGY



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Pacific Northwest National Laboratory
Richland, Washington 99352

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1.0 Introduction

The Pacific Northwest National Laboratory (PNNL) is supporting the Department of Homeland Security (DHS) to advance technologies to enhance responder health and address complex and changing threat environments. The DHS Science and Technologies First Responders Group established the Responder Technology Alliance (RTA) to accelerate the development of solutions to first responder needs and requirements by identifying, analyzing, and recommending solutions that improve responder safety, enhance their ability to save lives, and minimize property loss. The end goal is for RTA to develop and implement strategies that will make effective solutions available to first responders.

As part of technology foraging for the RTA, this report summarizes technologies that are relevant in the area of “wearables,” with the potential for use by first responders. The content was collected over the previous month(s) and reproduced from a general Internet search using the term wearables. Additional information is available at the websites provided. The content is organized by technology function including:

- Sensors – Devices that detect physiological, particle, and chemical activity
- Displays – Heads-up and body-worn visual displays
- Power – Wearable power systems including chargers, batteries, self-powering or harvesting technologies, and power supplies
- Integrated Communications – Voice and data communications systems utilizing Bluetooth, wireless, hands-free, ergonomically optimized systems, noise-filtering digital speakers or microphones, etc.
- Cameras – Body-worn photo and video cameras
- Breathing Apparatus – Wearable air supply and monitoring devices
- Exoskeletons – Whole or partial body suit that enhances mobility and physical performance
- Wearable Computers – Body-worn data processing devices
- General – Miscellaneous technologies as well as emerging trends or recent advances in the field of wearables.

This report is not meant to be an exhaustive list nor an endorsement of any technology described herein. Rather, it is meant to provide useful information about current developments in the area of wearable technology.

A spreadsheet summarizing these technologies is available in Appendix A. For an electronic copy, contact Jaki Upton at jaki.upton@pnnl.gov.

2.0 Sensors

2.1 Physiological

2.1.1 Acer: Liquid Leap

Technology name: Liquid Leap Fit and Curve wearable bands

Description: Acer's Liquid Leap wearable, waterproof wristbands feature a 1-inch touchscreen, stress sensors, heart rate monitors, and step tracking. The bands have an ARM Cortex processor, 16kb memory, Bluetooth connectivity, and 120-hour battery life.

Status: Evolving – currently available for shipping to Ireland and the United Kingdom

Funding:

Product link:

http://store.acer.com/store/aceremea/en_GB/list/ThemeID.26339800/parentCategoryID.50066100/categoryID.69349000

Source: Acer's new Liquid Leap wearable bands measure stress

<http://www.techworld.com.au/article/573372/acer-new-liquid-leap-wearable-bands-measure-stress/>

2.1.1 FREER Logic: BodyWave

Technology name: BodyWave armband

Description: The BodyWave is a compact, EEG armband that monitors and wirelessly relays brainwaves to a computer. The technology was developed for assisting children with ADHD, brain injury sufferers, and athletes by allowing for the measurement and analysis of brain signals.

Status: Available

Funding: NASA

Product link: http://spinoff.nasa.gov/Spinoff2013/cg_2.html

Source: The wearables from NASA that made it back to Earth

<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>



Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

2.1.2 Jockey: Staycool

Technology name: Staycool garments

Description: Staycool undergarments are designed to regulate skin temperature. The garments use Outlast® technology and Thermocules™ technology that absorbs heat to help users stay cool, reportedly up to 3 degrees. Various garments are available, including t-shirts and various styles of underwear.

Status: Available

Funding: NASA

Product link: <http://www.jockey.com/staycool>

Source: The wearables from NASA that made it back to Earth
<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

2.1.3 MagniWare: Magni

Technology name: Magni

Description: Magni combines hardware, software, and material science into a 5x3 cm, 2.5-mm-thick wearable that adheres to the body to collect and analyze physiological performance. The device “processes live data using advanced algorithms to notify users via mobile app of potential injury or other consequences resulting from strain, stress, and overexertion.” It can be removed and used thousands of times between chargings.

Status: Evolving

Funding:

Product link: <https://magniware.io/index.html>

Source: Toronto-based MagniWare creates “quantitative second skin” wearable
<http://betakit.com/toronto-based-magniware-creates-quantitative-second-skin-wearable/>



Photo source: <https://magniware.io/index.html>

2.1.4 Orbital Research: Portable Unit for Metabolic Analysis

Technology name: PUMA (Portable Unit for Metabolic Analysis)

Description: PUMA is a portable, rugged tool for measuring metabolic rates (oxygen, carbon dioxide, flow, temperature, pressure, and heart rate) and an assessing oxygen problems in a user. The device is under development for use in hospitals. The device is battery-powered and can measure metabolic function at rest, in motion, in the field, and in clinical settings.

Status: Evolving

Funding: NASA

Product link:

[http://microgravity.grc.nasa.gov/Advanced/HumanResearch/documents/Portable%20Unit%20for%20Metabolic%20Analysis%20\(PUMA\).pdf](http://microgravity.grc.nasa.gov/Advanced/HumanResearch/documents/Portable%20Unit%20for%20Metabolic%20Analysis%20(PUMA).pdf)

Source: The wearables from NASA that made it back to Earth

<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>



Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

2.1.5 NASA, GM: Robo-Glove

Technology name: Robo-Glove

Description: Designed by NASA and GM, Robo-Glove offers enhanced grip, reducing the amount of grip required, allowing the user to grip longer and more comfortably. The device features “tendons” and sensors that measure the user’s grasping force. Actuators in the glove provide grasping support; pressure sensors detect when the user is grasping something; and synthetic tendons retract, establishing the grip. The glove can either assist or resist movement to enable optimal grip for the user’s conditions. The device is reported to help reduce repetitive stress injuries.

Status: Evolving

Funding: NASA

Product link: http://www.nasa.gov/mission_pages/station/main/robo-glove.html

Source: The wearables from NASA that made it back to Earth
<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>



Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

2.1.6 Neumitra: neuma

Technology name: neuma bio-smartwatch

Description: The neuma biowatch measures the stress via the autonomic nervous system and alerts the user with vibration when it detects physiological anomalies (excessive sweating, heart rate, etc.). The Neumitra algorithms interpret the physiological data to help the user recognize and understand their stress levels, which users can review via tablet or smart device. The goal is that users can be alerted to their rising stress level and monitor their response.

Status: Available

Funding:

Product link: <https://www.neumitra.com/>

Source: Wearable Device Alerts You When You’re Stressed Out
<http://www.notimpossible.com/the-latest/wearable-device-alerts-you-when-youre-stressed-out>

2.1.7 Nokia

Technology name: Apparatus 600 wearable band

Description: Nokia patented a wearable band that can collect health data (heart rate, blood pressure, skin moisture). Compared to similar devices, Nokia's device will automatically contract to contact the skin and collect the data, then relax for the comfort of the user. The device is reported to potentially include a microphone, display, and camera. The band can be placed on various parts including the chest, wrist, and ankle.

Status: Evolving

Funding:

Product link: [Patent information](#)

Source: Nokia patents wearable device (Band) that can tighten & loosen automatically to do accurate data measurement

<http://www.nokiapoweruser.com/nokia-patents-wearable-device-band-that-can-enable-accurate-data-measurement/>

2.1.8 Quanttus

Technology name: Wrist-worn health monitor

Description: The Quanttus wristband is reported to be a "cuff-less, non-invasive blood pressure monitoring" device. The device is currently in clinical trials, being compared to standard blood pressure monitoring devices.

Status: Evolving

Funding: Quanttus has reportedly raised \$22 million in funding.

Product link:

Source: After staff shuffle, Quanttus will unveil wrist-worn health monitor this month

<http://www.betaboston.com/innovation-economy/2015/04/20/after-staff-shuffle-quanttus-will-unveil-wrist-worn-health-monitor-this-month/>

2.1.9 Teiken Limited, Kyoto University Hospital, and the Advanced Scientific Technology & Management Research Institute of Kyoto

Technology name: Electrocardiogram textile

Description: This wearable "e-textile" electrode fabric has embedded electrical circuits that can perform electrocardiogram (ECG) measurements. The fabric "incorporates eight of the 10 electrodes required for 12-lead ECG measurements" and can be wrapped around the user's torso or placed under the armpit. The fabric uses a "Nishijin-brocade technique" in which "one strand of conductive thread can be fabricated into a high-quality ECG-measuring fabric with electrodes and conducting wire in a stable, industrialized

fashion.” The goal is that the wearable textile will offer more efficient application of ECG in the field to improve emergency response and survival rates.

Status: Evolving

Funding:

Product link:

Source: Japanese fiber firm develops wearable electrocardiogram textile
<http://www.globalpost.com/article/6517039/2015/04/15/japanese-fiber-firm-develops-wearable-electrocardiogram-textile>

2.1.10 Zephyr: Bioharness

Technology name: Bioharness

Description: BioHarness is a physiological monitor (module, strap or compression shirt) that provides remote monitoring of human performance. Bioharness uses Bluetooth to communicate heart rate, speed, distance, breathing rate, GPS, posture, etc. The waterproof device has a 26-hour battery life per charge. It was originally designed to help astronauts track physiological systems to avoid gravity sickness; it is now in use by the U.S. Military, first responders, and sports teams.

Status: Available

Funding: NASA

Product link: <http://zephyranywhere.com/products/bioharness-3/>

Source: The wearables from NASA that made it back to Earth
<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

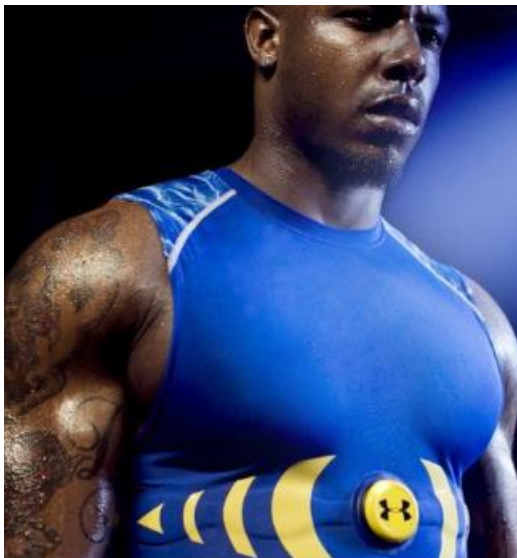


Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

2.2 Chemical/particulate

2.2.1 Columbia University

Technology name: Wearable air-monitoring sensors

Description: Researchers are exploring the use of “a sophisticated blend of sensors to measure personal exposure to air pollution.” The proposed research project will “demonstrate the efficacy of prototype devices for assessing environmental exposures,” measuring both air pollution and biometric data of cyclists. In addition to sensors to measure pollution, the project will include the use of a Hexoskin biometric t-shirt, which can measure breathing, heart rate, and recovery, and a MicroPEM with an accelerometer to measure exertion.

Status: Evolving

Funding: National Institute of Health award of \$250,000

Product link:

Source: Wearable Sensors Will Measure How Much Air Pollution City Cyclists Inhale
<http://nextcity.org/daily/entry/city-biking-breathe-air-pollution-sensors-wear-measure>

2.3 Other

2.3.1 imec

Technology name: Low-energy, multi-sensor signal analysis platform

Description: imec is proposing a low-energy multi-sensor signal analysis platform and machine-learning framework that “will learn the person’s movement, context, or more generally his/her habits, assess the respective signal-to-noise levels, and adapt signal analysis to the context” in order to provide quality personalized feedback and diagnostics to the user. The goal is for a “full patient monitoring system, capable of acquiring multimodal sensor signals, high quality features extraction, and performing online health classification based on the extracted features,” to ultimately benefit autonomous health monitoring.

Status: Evolving

Funding:

Product link:

Source: Context aware multi-sensor signal processing platform for wearable health applications (ref. S1506-20B)
http://www2.imec.be/be_en/education/phd/electronics-for-healthcare-and-l/context-aware-multi-sensor-signa.html

2.3.2 MetaWear

Technology name: MetaWear wireless sensor platform

Description: The MetaWear wireless sensor platform is a Bluetooth low-energy module that allows users to build and program Internet of Things projects from their smartphones. It features numerous sensors for measuring acceleration, orientation, velocity, temperature, pressure, altitude, and more. The data gathered is displayed real-time and can be exported into numerous formats for analysis and algorithm development. The technical details of the device include an ARM Cortex-M0 processor with 256KB of Flash and 16KB of RAM, rechargeable battery circuit with a microUSB port, exposed GPIOs and an I2C bus for additional sensors, a built-in LED and a push-button, and an approximate range of 100 feet and three weeks of continuous operation (and six months of idle time) on a single charge.

Status: Evolving

Funding: Crowdfunding

Product link: <https://www.mbientlab.com/>

Source: MetaWear is a mini wearable sensor platform
<http://blog.atmel.com/2015/04/22/metawear-is-a-mini-wearable-sensor-platform/>

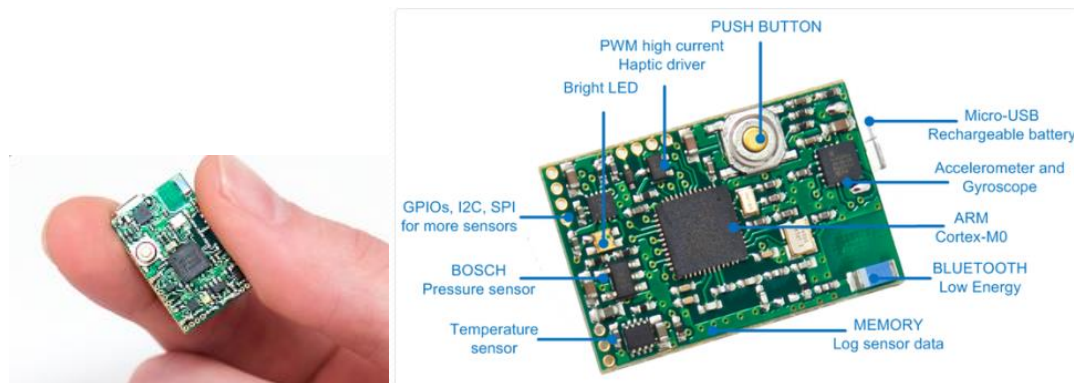


Photo source: <https://www.mbientlab.com/>

3.0 Displays

3.1 Heads-up

3.1.1 AR Devices: GogglePal

Technology name: GogglePal heads-up display

Description: Originally designed for skiers and snowboarders, GogglePal is a universally mountable heads-up display for goggles: “the small and lightweight GogglePal magnetically attaches to the lower corner of a user's goggle lens allowing them to track speed, vertical, calories burned, time, location and direction, all in real-time.” The device also allows users to connect with others, finding them on “digital trail map” and via messaging. It can withstand temperatures from -40 degrees Celsius to 80 degrees Celsius and features GPS, Bluetooth low-energy connectivity, and 8-hour battery life.

Status: Evolving

Funding: Crowdfunding; surpassed the \$40,000 target.

Product link: <http://www.gogglepal.com/>

Source: Newly Launched GogglePal Brings Augmented Reality to the Slopes with Announcement of Crowdfunding Campaign

<http://www.prnewswire.com/news-releases/newly-launched-gogglepal-brings-augmented-reality-to-the-slopes-with-announcement-of-crowdfunding-campaign-300072838.html>

3.1.2 Google: Google Glass

Technology name: Eye-tracking

Description: Google’s latest patent suggests Google is exploring eye-tracking as opposed to voice or tap gestures to control the device. Example applications include glancing at a building would generate a display of building details, contact information, etc.

Status: Evolving

Funding:

Product link: [Heads-up display patent file](#)

Source: The next Google Glass might have eye-tracking, give you info based on where you’re looking
<http://9to5google.com/2015/04/14/google-glass-2-eye-tracking/>

3.1.3 MINI, Qualcomm, Osterhout

Technology name: Augmented vision glasses

Description: MINI's augmented vision glasses offer stereoscopic HD displays, wifi, and Bluetooth connectivity, and GPS, and connect to the MINI Cooper's onboard MINI Connected app to display information (street signs, arrows, directions) on the heads-up display. The device can reportedly "scope out potential parking spaces by using the car's built-in technology to scan for spots large enough to fit the car." The device utilizes MINI's cameras and sensors to create "x-ray vision," which "works as a guide when the driver is parking, by showing a real-time view of your wheels through the car as you inch into a space.

Status: Evolving

Funding:

Product link:

Source: The people behind the MINI Cooper have created an incredible x-ray vision device for drivers that will blow you away

<http://www.businessinsider.com/mini-wants-you-to-wear-these-augmented-reality-glasses-while-you-drive-2015-4>



The MINI Augmented Vision glasses, a design collaboration between BMW Group/MINI, Qualcomm and San Francisco-based Osterhout Design Group.

Photo source: <http://www.businessinsider.com/mini-wants-you-to-wear-these-augmented-reality-glasses-while-you-drive-2015-4>

3.1.4 Pcddata USA

Technology name: Smart Glass

Description: Smart Glass is a "pick-to-vision" device that clips on and projects a computer screen onto glasswear. In product management scenarios, the user would look at 2D bar codes and the Smart Glass could display instructions. The hands-free device integrates with the Distrib AR software designed to interface with the client's management system.

Status: Evolving

Funding:

Product link: <http://www.pcddata.nl/products/picking-tools/distrib-ar>

Source: Pdata USA Launches Smart Glass Wearable Picking Technology
<http://www.digitaljournal.com/pr/2522503>

3.1.5 Recon Instruments: Recon Jet

Technology name: Recon Jet smart goggles

Description: The Recon Jet smart goggles feature “a dual-core CPU, high-contrast display and point-of-view camera while seamlessly connecting to smartphones and wearable sensors.” The device offers GPS and motion tracking, point-of-view camera, wifi and Bluetooth connectivity, an accelerometer, gyroscope, altimeter, barometer, and magnetometer, and it can pair with your smart devices for caller ID, SMS notifications, and social media access.

Status: Available

Funding:

Product link: <http://www.reconinstruments.com/products/jet/>

Source: Video: Recon Instruments shipping Jet wearable glasses
<http://www.vancouversun.com/technology/Video+Recon+Instruments+shipping+wearable+glasses/10978391/story.html>



Photo source: <http://store.reconinstruments.com/Jet>

3.1.6 Six15

Technology name: Smart glasses

Description: Six15 is exploring rugged “smart glasses designed for warehousing, manufacturing, and first responders.” Testing has included use of the military-grade Tac-Eye head-mounted display, which offers reduced energy use and longer battery life, thanks to a lower resolution display and wireless connection to an separate Android OS or central server. The end product will also be customizable and offer a sleeker design than most smart glasses currently on the market. Clients include Harris, Optics 1, and the United States Army, Navy, and Air Force.

Status: Evolving

Funding:

Product link: <http://www.six-15.com/>

Source: Designing Wearable Optics for Workplace Productivity
<http://www.pddnet.com/news/2015/04/designing-wearable-optics-workplace-productivity>



The military-grade Tac-Eye may be the basis for Spec15's industrial HMDs.

Photo source: <http://www.pddnet.com/news/2015/04/designing-wearable-optics-workplace-productivity>

3.1.7 Vuzix

Technology name: Gesture controls of 3D virtual objects and ambient light management for see-through displays

Description: Vuzix acquired a patent for a “Stereoscopic user interface method and apparatus,” which reported allows a user to use gesture controls to manipulate virtual 3D objects. Vuzix has also acquired a patent for “Selective real image obstruction in a virtual reality display apparatus and method,” which projects a virtual reality image in front of a wearer and allows for management of real image obstructions and ambient light. Gesture control with augmented reality vision managing the ambient light, especially in optical see-through glasses, is critical in the operation of wearables display technology.

Status: Evolving

Funding:

Product link: [Stereoscopic user interface method and apparatus patent file](#)
[Selective real image obstruction in a virtual reality display apparatus and method patent file](#)

Source: Vuzix Acquires Two New Patents in Wearable Display Space
<http://www.prnewswire.com/news-releases/vuzix-acquires-two-new-patents-in-wearable-display-space-300066986.html>

3.1.8 World Media and Technology Corp.: LUMINA™

Technology name: Lumina smart glasses

Description: Lumina smart glasses offer wearers “high quality, wire-free, infotainment experience delivering a high-resolution, wide screen binocular display with built-in stereo sound.” The glasses’ binocular display offers a 51” to 420” view. The device also features a 13MP camera, gyroscope, accelerometer, compass, GPS, microphones, full HD video recording, bone conduction speakers, data storage, Cloud-based connectivity, and a communications platform. The device is light weight, wire-free and works independently from tablets or computers.

Status: Evolving

Funding:

Product link: <http://www.worldmediatech.com/lumina-glasses/>

Source: WRMT Set To Secure First Revenues As It Unveils Its LUMINA™ Augmented Reality Glasses, Exclusively Through WOR(1)D Distribution Partners, At The Opening Of Its Miami Office
<http://money.cnn.com/news/newsfeeds/articles/prnewswire/AQ90953.htm>

3.2 Body worn (wrist, arm or chest)

3.2.1 Rufus Labs: Rufus Cuff

Technology name: Rufus Cuff

Description: The Rufus Cuff “wrist communicator” features a 3.2-inch wide touchscreen, web access, messaging, voice and video calling, accelerometer, gyroscope, compass, camera, browser, microphone, speaker (but no headphone jack), Bluetooth connectivity, scrolling capability, and changeable wristbands. It offers 1-2 days battery life and charges via microUSB.

Status: Soon to be released – available for pre-order

Funding: Crowdfunding – surpassed target

Product link: <http://rufuslabs.com/>

Source: Rufus Cuff Takes Wearable to the Bigger Picture
<http://www.siteproneews.com/2015/04/21/rufus-cuff-takes-wearable-to-the-bigger-picture/>



Photo source: <http://www.siteproneews.com/wp-content/uploads/2015/04/rufus.jpg>

4.0 Power

4.1 Chargers

4.1.1 Ossia: Cota

Technology name: Cota wireless charging chipset

Description: The Cota antenna and chipset can be used in mobile devices to enable wireless charging.. Compared to common devices, “Ossia’s Cota remote wireless power receiver uses a mobile device's existing antenna, eliminating internal coils needed by magnetic induction wireless charging systems.” Cota technology can receive wireless transmission within 30 feet and can charge multiple devices at one time. The light-weight, thin technology is fit for compact wearable devices and can also be used in stationary devices with regular batteries.

Status: Evolving – anticipated to ship in 2015

Funding:

Product link: <http://www.ossiainc.com/>

Source: Start-up touts wireless charging from Wi-Fi and Bluetooth signals
<http://www.computerworld.com/article/2904366/start-up-touts-wireless-charging-from-wi-fi-and-bluetooth-signals.html>

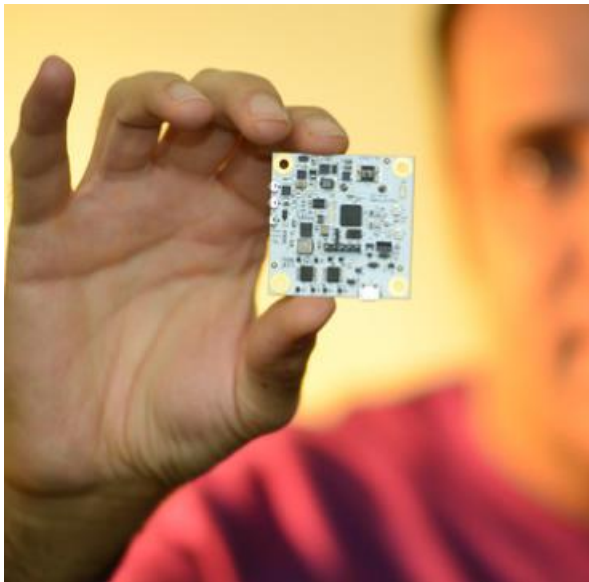


Photo source: <http://www.ossiainc.com/about/>

4.2 Self-powering (Harvesters)

4.2.1 CSIRO: Flexible Integrated Energy Device

Technology name: Flexible Integrated Energy Device

Description: The CSIRO Flexible Integrated Energy Devices comprises an energy harvesting system, a flexible battery, and washable fabric with conductive fibers that connect to other electronic devices. The end goal would be the ability to use the fabric in garments (shirts, backpacks, etc.) to connect with and charge devices.

Status: Evolving

Funding:

Product link:

Source: A Much Smarter Watch: How our flexible batteries and electrified fabrics can improve wearables

<http://csironewsblog.com/2015/04/29/a-much-smarter-watch-how-our-flexible-batteries-and-electrified-fabrics-can-improve-wearables/>

4.2.2 University of Waterloo

Technology name: Metamaterial medium for electromagnetic energy harvesting

Description: According to researchers, the metamaterial features “ 13×13 electrically small cells, each loaded with an 82Ω resistor which mimics the input impedance of a rectification circuitry. Unlike earlier designs of metamaterial absorbers, here the power absorption is mostly dissipated across a resistive load instead of the dielectric substrate. This implies that effective electromagnetic energy harvesting can be achieved.” Researchers reported “power absorption efficiency of 97% and 93%.”

Status: Evolving

Funding: Saudi Arabian Ministry of Higher Education and the Natural Sciences and Engineering Research Council of Canada.

Product link:

Source: Metamaterial electromagnetic energy harvester with near unity efficiency

<http://scitation.aip.org/content/aip/journal/apl/106/15/10.1063/1.4916232>

4.3 Power supplies

4.3.1 City University of Hong Kong

Technology name: Industrially weavable and knittable conductive yarns

Description: In this research, “Large energy storage textiles are fabricated by weaving [the] flexible all-solid state supercapacitor yarns to a 15 cm×10 cm cloth on a loom and knitting in a wool wrist band to form a pattern, enabling dual functionalities of energy storage capability and wearability.”

Status: Evolving

Funding: Early Career Scheme of the Research Grants Council of Hong Kong SAR, China (CityU 9041977) and the Science Technology and Innovation Committee of Shenzhen Municipality (JCYJ20130401145617276).

Product link:

Source: From Industrially Weavable and Knittable Highly Conductive Yarns to Large Wearable Energy Storage Textiles

<http://pubs.acs.org/doi/pdf/10.1021/acsnano.5b00860>

4.3.2 Stanford University

Technology name: Flexible aluminum battery

Description: The flexible aluminum battery charges in 1 minute and holds 2 volts and can be recharged thousands of times without capacity loss. Compared to previous attempts at aluminum batteries, Stanford researchers found the incorporation of graphite “lowers the barrier of the electrochemical reactions and allows fast charge and discharge.” The battery is also safe and durable.

Status: Evolving

Funding:

Product link:

Source: This Flexible Aluminum Battery Charges in One Minute

<http://www.popularmechanics.com/science/energy/a14945/flexible-aluminum-battery-charges-in-one-minute/>

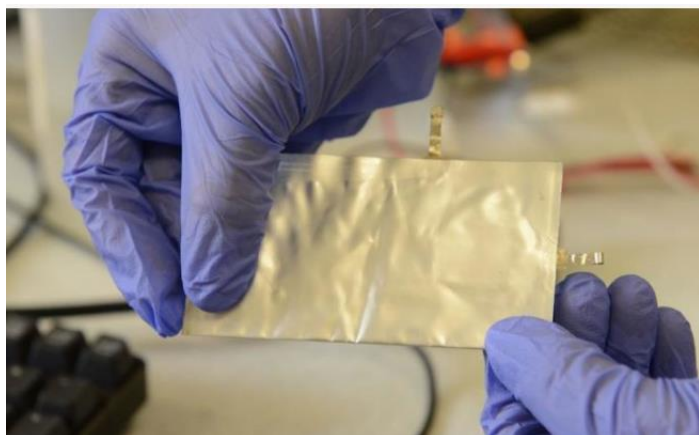


Photo source: <http://www.popularmechanics.com/science/energy/a14945/flexible-aluminum-battery-charges-in-one-minute/>

4.3.3 University of California

Technology name: Hybrid supercapacitor

Description: This high-energy, super-thin hybrid supercapacitor is “one-fifth the thickness of paper, however it can hold charge long enough to power the demo LED overnight.” The device combines graphene and manganese dioxide for an energy density that can reportedly achieve up to 42-Watt-hours per liter and does not require dry rooms or extreme temperatures for production. Researchers suggest the device will be good for 10,000 recharges and can recharge in in seconds, compared to conventional batteries that can take hours.

Status: Evolving

Funding:

Research link: <http://www.pnas.org/content/early/2015/03/20/1420398112>

Source: UCLA trumpets supercapacitor for wearables or implants
http://www.theregister.co.uk/2015/04/02/ucla_trumpets_supercap_for_wearables_or_implants/

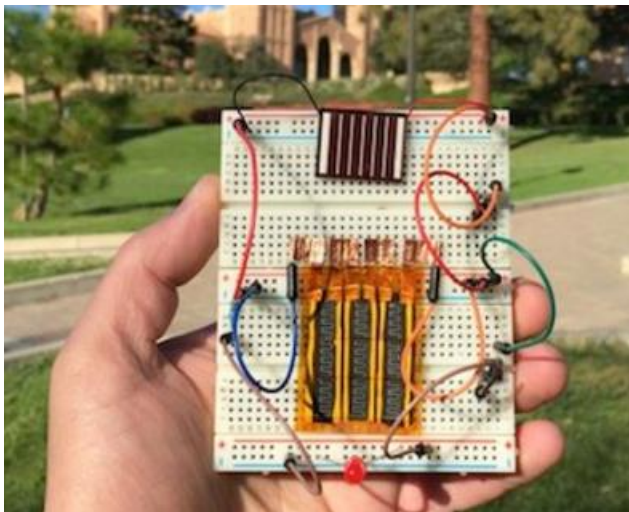


Photo source: http://www.theregister.co.uk/2015/04/02/ucla_trumpets_supercap_for_wearables_or_implants/

4.4 Power Reduction

4.4.1 Atmel: SAM L-21

Technology name: SAM L-21 microprocessor

Description: SAM L-21 low-power, ARM-powered microprocessor features “42Mhz Cortex CPU, 256KB of flash memory, 32KB of RAM and 8KB of low power RAM” and uses five modes of varying sleep levels to conserve energy. For example, it can go from full power to just showing the time. It can reportedly be powered off energy from the body. ARM technology is reportedly increasing wearable battery life by 60%

Status: Available

Funding:

Product link: <http://www.atmel.com/products/microcontrollers/arm/sam-l.aspx>

Source: Future wearables could last for decades on one charge with this ARM-powered chip
<http://www.wearable.com/wearable-tech/future-wearables-could-last-for-decades-on-one-charge-thanks-to-this-arm-powered-chip-1064>

4.4.2 Toshiba: TZ1001MBG

Technology name: TZ1001MBG microcontroller

Description: TZ1001MBG microcontroller low-power control technology addresses the need for a small battery and power control in wearable devices; as devices house increasingly more sensors, they expend more power. The device reportedly delivers a 31% reduction in power consumption by better controlling the frequency of transition from multiple sensors. The device uses “an ingenious aggregation method that reduces the total number of mode transitions.”

Status: Evolving

Funding:

Product link:

Source: Global wearable devices market leader Toshiba unveil new low power control technology
<http://www.companiesandmarkets.com/News/Information-Technology/Global-wearable-devices-market-leader-Toshiba-unveil-new-low-power-control-technology/NI10199>

5.0 Communications

5.1 Integrated voice/data/video

5.1.1 Soliton Systems K.K.: Zao

Technology name: Zao smart-telecaster

Description: The Zao smart-telecaster offers “hardware encoder designed for mobile broadcasting and first responder markets.” The device delivers high-quality, real-time streaming video, adjusting the video compression ratios to offer quality transmission even in low-reception. It provides audio and video capability and supports 8 mobile channels. The device’s use of H.265 reduces power consumption and footprint. The device offers built-in encryption and connection authentication. It also offers more than five hour battery life. The device was “fully field tested in bandwidth-scarce environments such as the Sochi Winter Olympics and several natural disasters.”

Status: Evolving

Funding:

Product link: <http://www.smart-telecaster.com/>

Source: Smart-Telecaster Zao Delivers H.265 Hardware Encoder for Mobile Broadcasting and First Responder Markets

<http://www.pr.com/press-release/613217>

Smart-telecaster *Zao*



Photo source: <http://www.smart-telecaster.com/main.php>

5.2 Short-range low-power Bluetooth

5.2.1 MSA, Motorola

Technology name: Integrated Bluetooth communications for self-contained breathing apparatus

Description: MSA and Motorola Solutions are integrating Bluetooth and APX radio technology into self-contained breathing apparatus to enable firefighters to communicate more clearly in noisy

environments. The capability was initially unveiled for use by operators using the MSA G1 SCBA mask and a Motorola Solutions APX P25 radio. To operate, the Bluetooth-connection in the breathing apparatus and the APX radio are paired similarly to how a cell phone pairs with a car stereo, creating a clearer link for communication. The microphone is integrated as part of the voice port of the regulator.

Status: Available

Funding:

Product link:

Source: MSA, Motorola Solutions create a Bluetooth solution to improve voice communications on fireground

<http://urgentcomm.com/fireems/msa-motorola-solutions-create-bluetooth-solution-improve-voice-communications-fireground>

5.3 Wearable, hands-free operation

5.3.1 Makeroni: Eye of Horus

Technology name: Eye of Horus 3D-printed, open-source platform

Description: Eye of Horus uses sight to allow users to control devices hands-free. Light beacons focus on a device and emit various frequency pulses for each device. A camera detects the light and communicates wirelessly with the objects as the wearer glances at them. The device is 3D-printable and open-source with a custom Bluetooth module, relay-control module, infrared LED, and Arduino Pro Mini processor.

Status: Evolving

Funding: Crowdfunding

Product link: <http://makeronilabs.com/proyectos/37-eye-of-horus-open-source-eye-assistance>

Source: This wearable device lets you control objects by simply looking at them

<http://blog.atmel.com/2015/04/30/this-wearable-device-lets-you-control-objects-by-simply-looking-at-them/>

5.4 Other

5.4.1 AWIRE

Technology name: AWIRE two-way radio

Description: The AWIRE two-way radio integrates with a smartphone. The technology comprises the AWIRE smartphone app, Bluetooth connectivity, UHF radio. AWIRE pairs with a smartphone without draining data or battery life, is light weight, uses one-button operation, and connects and communicates to other devices within a 2-mile radius, even if you are off the grid.

Status: Evolving

Funding: Crowdfunding

Product link: <https://www.kickstarter.com/projects/2132408298/awiretm-share-the-adventure>

Source: AWIRE™ - SHARE THE ADVENTURE
<https://www.kickstarter.com/projects/2132408298/awiretm-share-the-adventure>

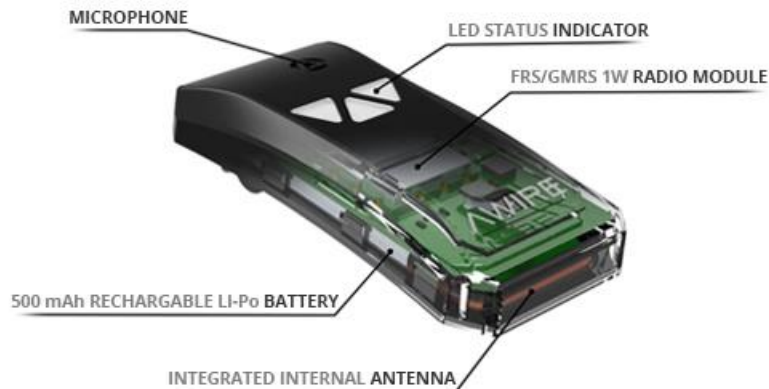


Photo source: <https://www.kickstarter.com/projects/2132408298/awiretm-share-the-adventure>

5.4.1 Generator Research: Body wifi

Technology name: Body wifi

Description: Body wi-fi, or wi-bo, would establish a single control device as the interface for the rest of the body network to provide a smooth connection of multiple wearables. The wifi would “operate on frequencies above the usual spectrum used by cellular networks, between 10 and 20GHz. These high frequencies would be used to connect all the wearables to the controller which would subsequently connect the whole network to a Wi-Fi system in the office or home environment.”

Status: Evolving

Funding:

Research link: <http://www.generatorresearch.com/tekcarta/analysis-insight/now-that-wi-fi-is-done-its-time-for-wi-bo-wireless-body>

Source: Researchers propose body WiFi for the wearable technology age
<http://eandt.theiet.org/news/2015/apr/body-wifi.cfm>

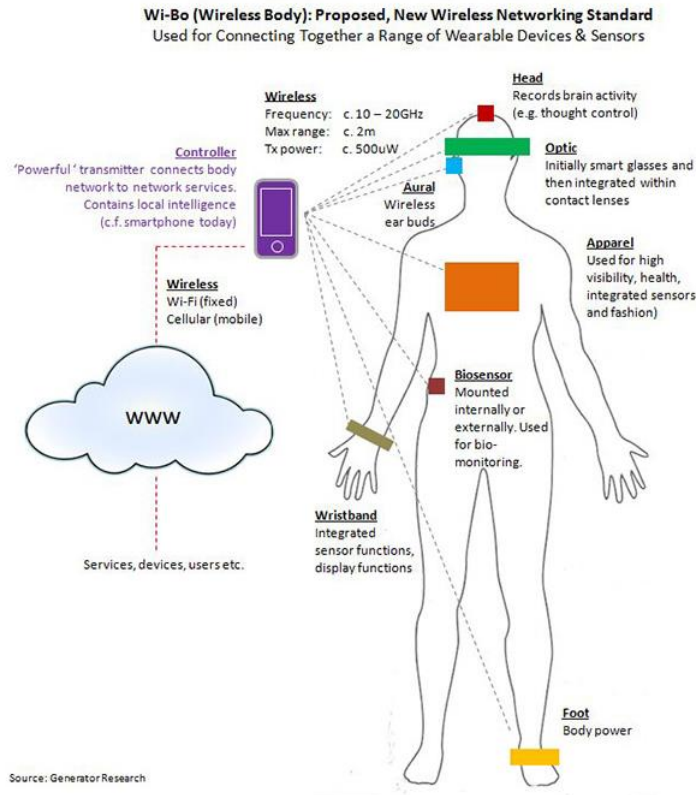


Photo source: <http://www.generatorresearch.com/tekcarta/analysis-insight/now-that-wi-fi-is-done-its-time-for-wi-bo-wireless-body>

5.4.2 Google: Android Wear

Technology name: Android Wear

Description: In comparison to Apple Watch's dependence on the iPhone, Android Wear communicates with a user's Android devices over wifi or cellular data connection, reducing the need for the user to have their phone nearby at all times. Even if you're at a location using wifi, the device will still communicate with your phone over cellular data. Android Wear reportedly "improves access to apps by making them accessible with a tap on the watch face. Apps can now be set to stay on-screen without slipping into battery-preserving sleep. And users can now flip through notifications and cards in their stream with the flick of a wrist." The technology also "attempts to recognize drawings so it can send the corresponding professionally-rendered emoji icon in place of the user's scrawl."

Status: Evolving

Funding:

Product link:

Source: Android Wear Promises Less Phone Dependence

<http://www.informationweek.com/mobile/mobile-devices/android-wear-promises-less-phone-dependence/d/d-id/1320052>

6.0 Cameras

6.1.1 DirectView Holdings Inc.

Technology name: Body cameras

Description: DirectView Holdings, Inc. will soon debut a next-generation body camera that will pair with its subscription cloud storage. The device will reportedly leverage the company's security video technology experience, with embedded fingerprint reader as well as Bluetooth, wi-fi and LTE connectivity.

Status: Soon to be released

Funding:

Product link:

Source: DirectView Announces Entrance Into Next Generation Body Camera / Wearable Camera and Video Storage Market

<http://www.4-traders.com/news/DirectView-Announces-Entrance-Into-Next-Generation-Body-Camera--Wearable-Camera-and-Video-Storage-M--20180994/>

7.0 Exoskeletons

7.1.1 Cadence Biomedical: Kickstart

Technology name: Kickstart wearable neuro-rehabilitation device

Description: Kickstart wearable neuro-rehabilitation device accelerates walking recovery and functional improvements after injury. It features the “bio-inspired” Exotendon technology that is essentially an artificial tendon that assists with stability and movement.

Status: Available

Funding:

Product link: <http://www.cadencebiomedical.com/>

Source: Kickstart Wearable Neuro Rehab Device Expands to Southeastern U.S.
<http://www.rehabpub.com/2015/04/kickstart-wearable-neuro-rehab-device-expands-southeastern-u-s/?ref=cl-title>



Photo source: <http://www.cadencebiomedical.com/>

7.1.2 Carnegie Mellon University

Technology name: Motor-free walking assistance device

Description: The motor-free exoskeleton “hydraulic cast” straps on from the knee to ankle and can reportedly reduce the energy required to walk by 7 percent. Instead of a motor or power source, the device uses a spring that stores and releases energy and an innovative clutch that mimics calf muscles.

Status: Evolving

Funding:

Product link:

Source: In the long run, wearable exoskeleton boot makes walking easier
<http://jacksonville.com/breaking-news/2015-04-01/story/long-run-wearable-exoskeleton-boot-makes-walking-easier>



Photo source: Carnegie Mellon University

8.0 Wearable Computers

8.1.1 LG

Technology name: Wearable smartphone

Description: LG has patented a smartphone that can turn into a smartwatch. The proposed device would be flexible and with a magnet-closing strap bracelet.

Status: Evolving

Funding:

Product link:

Source: LG patents wearable smartphone
<http://walyou.com/lg-patents-wearable-smartphone/>

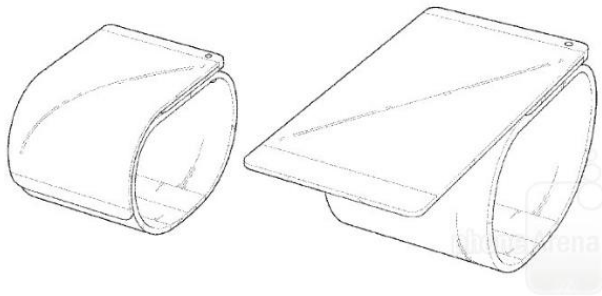


Photo source: <http://walyou.com/lg-patents-wearable-smartphone/>

8.1.2 Samsung

Technology name: Smartphone smartwatch

Description: Samsung patented a flexible smartphone that doubles as a smartwatch. The device will reportedly feature a large, flexible, touchscreen OLED display. It will likely play multimedia and allow users to make calls.

Status: Evolving

Funding:

Product link:

Source: Samsung's next wearable could be a bendy smartphone for your wrist
<http://www.trustedreviews.com/news/samsung-s-next-wearable-could-be-a-bendy-smartphone-for-your-wrist>

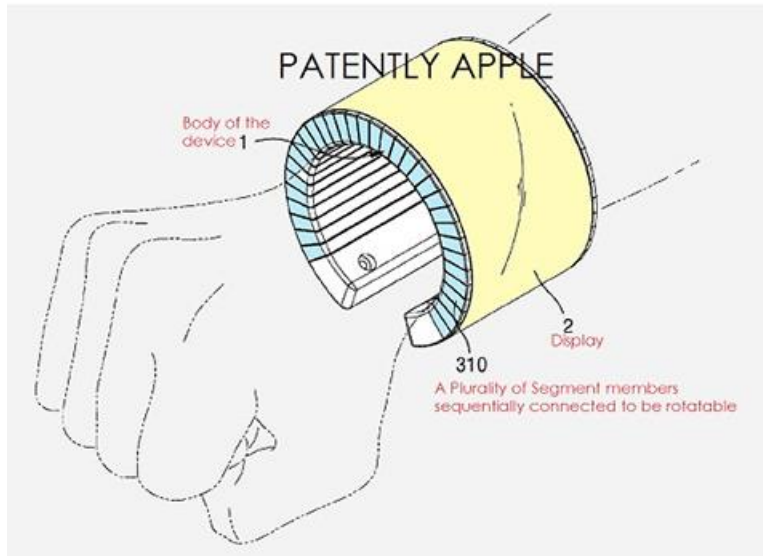


Photo source: <http://www.patentlymobile.com/2015/04/samsung-slowly-advances-their-next-gen-smartwatch-that-will-support-a-much-wider-flexible-display.html>

9.0 Other

9.1.1 Cadence Design Systems Inc.: Fusion DSP

Technology name: Fusion Digital Signal Processor (DSP)

Description: Fusion DSP offers a configurable core, low-power consumption (25% less), and a small footprint fit for wearables. The device reportedly offers “indoor navigation, context-aware sensor fusion, secure local wireless connectivity, face trigger, voice trigger and voice recognition functions.” It utilizes wi-fi, Bluetooth, and global navigation satellite connectivity. Fusion DSP “combines a 32-bit Xtensa control processor with flexible algorithm-specific acceleration for a fully programmable approach. Fusion includes quad 16-bit MACs for real and complex math, AES-128 encryption hardware support and audio and voice compatibility with Tensilica HiFi architecture. The Fusion comes with a library of DSP functions and more than 150 audio/voice/fusion applications from over 70 partners.”

Status: Evolving

Funding:

Product link: www.cadence.com/news/TensilicaFusionDSP

Source: Tensilica Fusion DSP Aims at IoT, Wearables
<http://electronics360.globalspec.com/article/5260/tensilica-fusion-dsp-aims-at-iot-wearables>

9.1.2 Dialog Semiconductor PLC: SmartBond DA14680

Technology name: SmartBond DA14680 “Wearable-on-Chip”

Description: The SmartBond DA14680 “Wearable-on-Chip” is a single-chip solution that reduces power consumption and form factor and offers Bluetooth Smart connectivity with wearables and smart home devices.

Status: Evolving

Funding:

Product link: <http://www.dialog-semiconductor.com/docs/site-pdf/dialog-smartbond-da14680-product-brief.pdf?sfvrsn=2>

Source: Dialog Semiconductor’s new Wearable-on-Chip integrates top functions
<http://www.wearables.com/dialog-semiconductors-new-wearable-on-chip-integrates-top-functions/>

9.1.3 Draper Laboratory

Technology name: 3D tracking wearable

Description: Draper Laboratory is developing a wearable device that will track astronauts’ as they move around the International Space Station, providing data that can be used to create 3D models of the users’ habitat to inform future designs. Optical sensors will “determine the astronaut’s location within the ISS

relative to other objects, as well as inertial measurement units and algorithms that, when packaged into an integrated system, can provide continuous information about movement and orientation.”

Status: Evolving

Funding:

Product link:

Source: ISS Astronauts get 3D Tracking Wearable developed by Draper Laboratory
<http://www.i4u.com/2015/04/89903/iss-astronauts-get-3d-tracking-wearable-developed-draper-laboratory>

9.1.1 Exist

Technology name: Exist

Description: Exist is designed to help users make better use of the mass of data being gathered by their wearable devices. Exist gathers data from users’ existing services and can review a user’s data over the past 90 days to identify and track trends or changes as well as to set new goals. The Exist software displays a dashboard with a user’s performance and it analyzes performance patterns. It also allows a user to manually enter information such as mood.

Status: Available

Funding:

Product link: <https://exist.io/>

Source: Can We Find Meaning In Our Wearable Data? Exist Thinks So
<http://readwrite.com/2015/04/20/finding-meaning-in-fitness-data-exist>

9.1.2 Felix

Technology name: Felix tactile bracelet

Description: Felix bracelet syncs with a smartphone and alerts users through eight electro-tactile pads. The device helps a user interact with their surroundings. It uses an open-source platform to customize alerts and can work with user’s social media, games, GPS, etc.

Status: Evolving

Funding: Crowdfunding

Product link: <http://www.felix.co/>

Source: Bahraini wearable could add a new dimension to social interaction
<http://www.wamda.com/2015/04/bahraini-wearable-new-dimension-social-interaction>



Photo source: <http://www.feelix.co/>

9.1.3 IBM: Watson Health Cloud

Technology name: Watson Health Cloud

Description: Watson is designed to provide multiple users (physicians, insurance companies, health practitioners, etc.) secured access to patient data. The technology intends to leverage the growing use of wearable-generated health data to provide real-time health data to doctors.

Status: Available

Funding:

Product link: <http://www.ibm.com/smarterplanet/us/en/ibmwatson/health/>

Source: IBM Launches Watson Health Cloud, So Your Doctor Can See Your Wearable Data
<http://www.fastcoexist.com/3045002/ibm-launches-watson-health-cloud-so-your-doctor-can-see-your-wearable-data>

9.1.1 Imagination: Enigma Whisper

Technology name: Enigma Whisper System on Chip wireless intellectual property

Description: The Enigma Whisper low-power system-on-chip technology offers a Bluetooth Low-Energy, Wi-fi, and combination model, with a goal to expand to offer mesh networking. The technology provides users access to Imagination's Radio Processing Unit, including antenna, software, radiofrequency transceivers, baseband processing and more. Whisper improves efficiency by saving metadata about the synchronization and decoding in order to take short cuts in synchronizing and decoding future packets. Whisper operates on 20-40 MHz and 8-bit data path, compared to 80 mhz/10-bit data path of common devices. Imagination's Flow Cloud stack offers connectivity of devices, device and user management, data logging, event handling, asynchronous messaging, e-payments, and internet radio. Imagination plans to expand the device to incorporate protocols including LTE CAT 0/1, 802.15.4 and 802.11ah. This will provide more mobility and networking capabilities.

Status: Evolving

Funding:

Product link: <http://www.imgtec.com/investors/detail.asp?ID=975>

Source: Imagination Launches New Low Power Wireless IP: Enigma Whisper
<http://www.anandtech.com/show/9154/imagination-launches-new-low-power-wireless-ip-whisper>

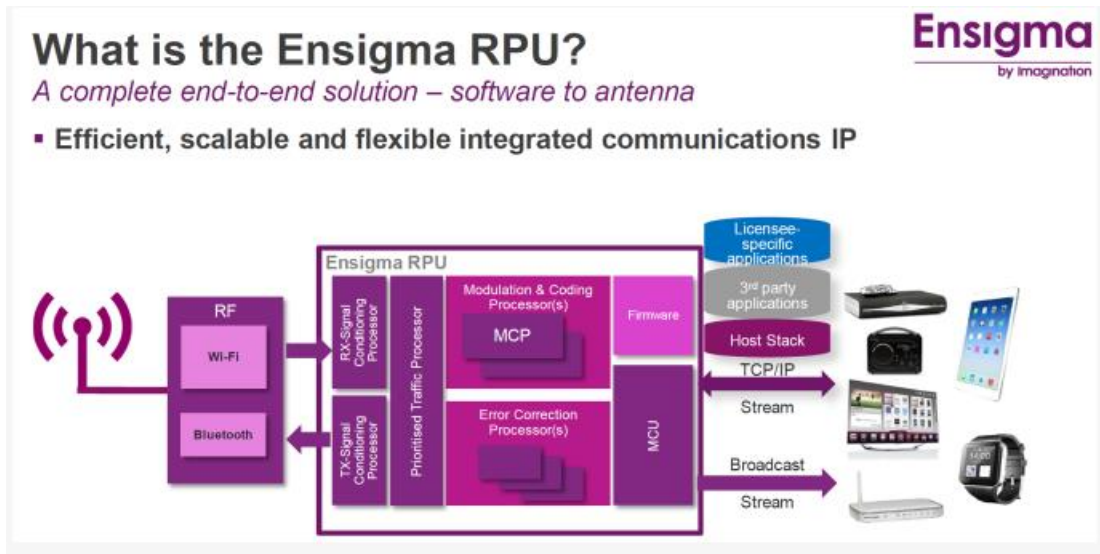


Photo source: <http://images.anandtech.com/doci/9154/overview.PNG>

9.1.1 Johnson Space Center, Ministry of Supply: Apollo Shirt

Technology name: Apollo Shirt

Description: The Johnson Space Center initially created phase-change materials for astronaut gloves to help them regulate body temperature in space by pulling moisture away from the body. Ministry of Supply applied the technology to the Apollo shirt, made of phase-change material-infused polyester. The technology absorbs heat from the skin and it evaporates at the shirt's exterior, allowing the user to maintain an optimal body temperature.

Status: Available.

Funding: NASA

Product link: <http://ministryofsupply.com/products/apollo>

Source: The wearables from NASA that made it back to Earth
<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>



Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

9.1.2 Metrarc

Technology name: SecureIoT

Description: The project is focused on improving security of personal data gathered by wearable technology. The project will “investigate the proof-of-concept for employing new and innovative secure system techniques to prevent cybercrime and protect our privacy as more and more of our smart devices are linked together automatically.” The project will employ Metrarc’s ICMetric technology which does not store encryption keys or other security data.

Status: Evolving

Funding: £2 million of funding from the EPSRC and the European Union and Innovate UK

Product link:

Source: Cambridge startup battles cyber threat on wearables

<http://www.businessweekly.co.uk/news/hi-tech/cambridge-startup-battles-cyber-threat-wearables>

9.1.3 Microsoft

Technology name: Emotion detection

Description: Microsoft patented emotion detection for wearables, such as augmented reality smart glasses like HoloLens. The technology would track a user’s emotion and offer activities to address them as well as detect emotions from people in the vicinity of the user. The technology would assess emotions by detection fluctuations in body temperature, tone, vocabulary, and facial expressions.

Status: Evolving

Funding:

Product link:

Source: Emotion Detection with HoloLens: Microsoft patents revolutionary technology

<http://www.geeksnack.com/2015/04/29/emotion-detection-with-hololens-microsoft-patents-revolutionary-technology/>

9.1.4 Mission Ready Services Inc.: Next-Generation Body Armor System

Technology name: Next-Generation Body Armor System

Description: Mission Ready Services' Next-Generation Body Armor System is nearing its final stages of prototyping for the US Army. The system integrates protective modules into a lightweight upper extremity system that provides greater protection. The project received "overwhelming approval ratings." Mission Ready Services specializes in solutions for first responder markets.

Status: Evolving

Funding:

Product link:

Source: Mission Ready to Launch Next Generation Body Armor

http://www.marketwatch.com/story/mission-ready-to-launch-next-generation-body-armor-2015-04-23?reflink=MW_news_stmp

9.1.5 MIT Media Lab: NailO

Technology name: NailO finger-mounted gestural input surface

Description: NailO is a wearable for your fingernail. NailO's multilayered miniaturized hardware affixes to a nail and transmits data via Bluetooth and allows a user to control devices via swipe gestures (with 92 percent accuracy). The device comprises a battery, microcontroller, Bluetooth radio chip, and capacitive-sensing chip. Developers aim to allow users to map gestures to specific actions.

Status: Evolving

Funding:

Product link: <http://nailo.media.mit.edu/>

Source: NailO turns your fingernail into a tiny trackpad

<http://www.cnet.com/news/nailo-out-of-mit-turns-your-fingernail-into-a-mini-trackpad/>



Photo source: <http://www.cnet.com/news/nailo-out-of-mit-turns-your-fingernail-into-a-mini-trackpad/>

9.1.6 Purdue University

Technology name: Inkjet-printed liquid metal

Description: Inkjet-printed liquid alloys may enable creation of elastic or flexible electronic circuits that benefit the creation of “pliable robots and stretchable garments.” These devices could allow users to interact with computers or other devices. Researchers propose printed, flexible conductors could be integrated into various materials and fabrics.

Status: Evolving

Funding:

Product link:

Source: Inkjet-printed liquid metal could bring wearable tech, soft robotics

<http://www.purdue.edu/newsroom/releases/2015/Q2/inkjet-printed-liquid-metal-could-bring-wearable-tech,-soft-robotics.html>

9.1.7 Raytheon: Boomerang Warrior-X

Technology name: Boomerang Warrior-X wearable shooter detection system

Description: Boomerang Warrior-X is designed to improve the safety of troops. The lightweight (12 ounce) wearable shooter detection system notifies users of fire attack and gives unit leaders a sniper’s grid coordinates. The device comprises built-in earpieces and a wrist display. The device integrates with the Aviation Warrior System that utilizes “maps, sensor imagery, video and messaging data from multiple military networks and is integrated with a survival radio and GPS. There’s also a thin display that can be worn on the wrist, leg or vest, allowing the system to work away from a helicopter or plane.” The device also employs smart glasses to display visual data in front of the user.

Status: Evolving

Funding:

Product link:

Source: Wearable Military Tech Spots Targets and Threats

<http://news.discovery.com/tech/gear-and-gadgets/wearable-military-tech-spots-targets-and-threats-150407.htm>

9.1.8 Redpoint Positioning Corporation

Technology name: Redpoint real-time location system

Description: Redpoint aims to combine real-time tracking and safety alerts to benefit construction job sites. The safety alert solution offers “high precision real-time location accuracy to within 8” and a lightweight mesh infrastructure that can be battery powered” and can be embedded into safety vests where it delivers visual and audible alerts. Redpoint real-time location technology integrates sensors, people tracking and navigation, and asset tracking.

Status: Evolving

Funding:

Product link: <http://www.redpointpositioning.com/>

Source: Redpoint Positioning Showcases Wearable Safety Alert System for Industrial Construction Sites

<http://www.prweb.com/releases/2015/04/prweb12680032.htm>

9.1.9 Rice University, David Eagleman (Individual): VEST

Technology name: Versatile Extra-Sensory Transducer (VEST)

Description: The VEST interprets sound: “An app downloaded onto a smartphone or tablet with a microphone will pick up sounds and send them via bluetooth to the vest. The vest will then “translate” those sounds into a series of vibrations that reflect the frequencies picked up by the mic by using a network of transducers—devices that can convert the signals into vibrations.” The vibration patterns are intended to be interpreted like braille.

Status: Evolving

Funding: Crowdfunding

Product link: https://www.kickstarter.com/projects/324375300/vest-a-sensory-substitution-neuroscience-project/video_share

Source: The Wearable Device That Could Unlock a New Human Sense

<http://www.theatlantic.com/technology/archive/2015/04/the-wearable-device-that-could-unlock-a-new-human-sense/390273/>

9.1.10 Royal Phillips: CareSage

Technology name: CareSage predictive analytics engine

Description: CareSage combines data from wearable devices with predictive analytics to provide enhanced health monitoring. CareSage integrates with the Philips HealthSuite Digital Platform cloud to collect and analyze data from multiple wearable devices. The system is anticipated to help “provide better preventative care and care coordination; increase patient satisfaction and improve quality of life issues; reduce long-term (beyond 30 days) avoidable readmissions; and improve health outcomes and cost savings.”

Status: Evolving

Funding:

Product link:

Source: Philips Lifeline introduces new predictive analytics engine to power population health management

http://www.marketwatch.com/story/philips-lifeline-introduces-new-predictive-analytics-engine-to-power-population-health-management-2015-04-13?reflink=MW_news_stmp

9.1.11 Royal Phillips, Leiden University Medical Center

Technology name: Wearable data analytics

Description: This research collaboration aims to improve preventative and chronic care through wearable technologies: “Philips and LUMC will jointly run clinical trials to identify and improve how people respond to lifestyle intervention programs. By analyzing health and wearable sensor data, the partners aim to gain fundamental new insights into how innovative technologies and coaching programs can effectively impact personal lifestyle and health—particularly in people who are at risk of or suffering from chronic conditions.” The goal is to “generate key data for developing algorithms to assess physiological and behavioral parameters such as activity, sleep, exercise, and sedentary time. The partners will also work on algorithms to translate this information into insights on how users are adhering to their treatment plans and achieve their personal goals.”

Status: Evolving

Funding:

Product link:

Source: Philips, Leiden University Medical Center Extend Collaboration with New Research Agreement
<http://www.sleepreviewmag.com/2015/03/philips-leiden-university-medical-center-extend-collaboration-new-research-agreement/>

9.1.12 Ulm University: Belt

Technology name: Belt

Description: Belt features a grid of touch-sensitive studs that allow a user to control (scroll, select, etc.) their display wearable devices.

Status: Evolving

Funding:

Research link: <http://dl.acm.org/citation.cfm?id=2702450>

Source: A Touch-Sensitive Belt Lets You Subtly Control A Wearable Display
<http://www.gizmodo.com.au/2015/04/a-touch-sensitive-belt-lets-you-subtly-control-a-wearable-display/>



Photo source: <http://www.gizmodo.com.au/2015/04/a-touch-sensitive-belt-lets-you-subtly-control-a-wearable-display/>

9.1.1 Vasper

Technology name: Vasper compression technology

Description: Vasper compression technology focus on “vascular performance,” concentrating lactic acid buildup in the muscles to enable more efficient exercise. Users wear a cooling vest and compression sleeves while exercising for 20 minutes, followed by 10 minutes of decompression and cooling. The concept is that through the compression, blood vessels deliver oxygen and nutrients to the cells to drive out toxins, improving health.

Status: Available

Funding: NASA

Product link: <http://www.vasper.com/what-is-vasper/the-vasper-effect>

Source: The wearables from NASA that made it back to Earth
<http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>



Photo source: <http://www.wearable.com/wearable-tech/wearable-gadgets-nasa-that-have-made-it-back-to-earth-373>

Appendix A

Technology Summary

Appendix A

Technology Summary

The following spreadsheet provides a summary of the technologies compiled in this report. For an electronic copy, please contact Jaki Upton at jaki.upton@pnnl.gov. *This information is not meant to be an exhaustive list nor an endorsement of any technology described herein.*

Company	Technology	Description	Status
Sensor			
Physiological			
Acer	Liquid Leap	Waterproof wristbands featuring a 1-inch touchscreen, stress sensors, heart rate monitors, and step tracking. The bands have an ARM Cortex processor, 16kb memory, Bluetooth connectivity, and 120-hour battery life.	Evolving
FREER Logic	BodyWave armband	Compact, EEG armband that monitors and wirelessly relays brainwaves to a computer.	Available
Jockey	Staycool garments	Clothing that regulates skin temperature. The garments use Outlast® technology and Thermocules™ technology that absorbs heat to help users stay cool, reportedly up to 3 degrees. Various garments are available, including t-shirts and various styles of underwear.	Available
MagniWare	Magni	Adheres to the body to collect and analyze physiological performance; algorithms analyze data and notify users via mobile app of stressors or overexertion. It can be removed and used thousands of times between chargings.	Evolving
NASA, GM	Robo-Glove	Offers enhanced grip, reducing the amount of grip required. Actuators in the glove provide grasping support; pressure sensors detect when the user is grasping something; and synthetic tendons retract, establishing the grip.	Evolving
Neumitra	Neuma bio-smartwatch	Measures the stress via the autonomic nervous system and alerts the user with vibration when it detects physiological anomalies. algorithms interpret the physiological data to help the user recognize and understand their stress levels, which users can review via tablet or smart device.	Available
Nokia	Apparatus 600 wearable band	Wearable band that collects health data (heart rate, blood pressure, skin moisture) and will automatically contract to contact the skin and collect the data, then relax for the comfort of the user.	Evolving
Orbital Research	Portable Unit for Metabolic Analysis (PUMA)	Portable, rugged tool for measuring metabolic rates (oxygen, carbon dioxide, flow, temperature, pressure, and heart rate) and an assessing oxygen problems in a user	Evolving
Quanttus	Wrist-worn health monitor	Cuff-less, non-invasive blood pressure monitoring device	Evolving
Teiken Limited, Kyoto University Hospital, and the Advanced	Electrocardiogram textile	e-textile electrode fabric with embedded electrical circuits that can perform electrocardiogram (ECG) measurements	Evolving

Scientific Technology
& Management
Research Institute of
Kyoto
Zephyr

[Bioharness](#)

Physiological monitor (module, strap or compression shirt) that provides remote monitoring of human performance. Uses Bluetooth to communicate heart rate, speed, distance, breathing rate, GPS, posture, etc. The waterproof device has a 26-hour battery life per charge.

Available

Chemical/Particulate

Columbia University

[Wearable air-monitoring sensors](#)

A demonstration of using multiple sensors to measure personal exposure to air pollution. The project will include the use of a Hexoskin biometric t-shirt, which can measure breathing, heart rate, and recovery, and a MicroPEM with an accelerometer to measure exertion.

Evolving

Other

imec

[Low-energy, multi-sensor signal analysis platform](#)

Low-energy multi-sensor signal analysis platform and machine-learning framework that will learn the user's movement, context, or habits; assess the signal-to-noise levels; and adapt signal analysis in order to provide quality personalized feedback and diagnostics to the user.

Evolving

MetaWear

[MetaWear wireless sensor platform](#)

Wireless sensor Bluetooth low-energy module that allows users to build and program Internet of Things projects from their smartphones. It features numerous sensors for measuring acceleration, orientation, velocity, temperature, pressure, altitude, and more. The data gathered is displayed real-time and can be exported into numerous formats for analysis and algorithm development.

Evolving

Displays

Heads-Up Displays

AR Devices

[GogglePal heads-up display](#)

Universally mountable heads-up display for goggles. Magnetically attaches to a user's goggles allowing them to track speed, vertical, calories burned, time, location and direction, all in real-time.

Evolving

Google

[Google Glass](#)

Google's latest patent suggests Google is exploring eye-tracking as opposed to voice or tap gestures to control the device.

Evolving

MINI, Qualcomm,
Osterhout

[Augmented vision glasses](#)

Augmented vision glasses with stereoscopic HD displays, wifi, and Bluetooth connectivity, and GPS, and connect to the MINI Cooper's onboard MINI Connected app to display information (street signs, arrows, directions) on the

Evolving

Pcdata USA	Smart Glass	heads-up display. A “pick-to-vision” device that clips on and projects a computer screen onto glasswear. Integrates with the Distrib AR software designed to interface with the client’s management system.	Evolving
Recon Instruments	Recon Jet smart goggles	Goggles with a dual-core CPU, high-contrast display and point-of-view camera while seamlessly connecting to smartphones and wearable sensors.” The device offers GPS and motion tracking, point-of-view camera, wifi and Bluetooth connectivity, an accelerometer, gyroscope, altimeter, barometer, and magnetometer, and it can pair with your smart devices for caller ID, SMS notifications, and social media access.	Available
Six15	Smart glasses	Rugged smart glasses featuring military-grade Tac-Eye head-mounted display.	Evolving
Vuzix	Gesture controls of 3D virtual objects and ambient light management for see-through displays	Stereoscopic user interface method and apparatus allowing a user to use gesture controls to manipulate virtual 3D objects and a selective real image obstruction in a virtual reality display apparatus and method, which projects a virtual reality image in front of a wearer and allows for management of real image obstructions and ambient light.	Evolving
World Media and Technology Corp	Lumina smart glasses	Smart glasses with a high-resolution, wide screen binocular display with built-in stereo sound	Evolving
Rufus Labs	Rufus Cuff	Wrist communicator with a 3.2-inch wide touchscreen, web access, messaging, voice and video calling, accelerometer, gyroscope, compass, camera, browser, microphone, speaker (but no headphone jack), Bluetooth connectivity, scrolling capability, and changeable wristbands. It offers 1-2 battery life and charges via microUSB.	Soon to be released
Power			
Chargers			
Ossia	Cota wireless charging chipset	Antenna and chipset for use in mobile devices to enable wireless charging. This remote wireless power receiver uses a mobile device's existing antenna, eliminating internal coils needed by magnetic induction wireless charging systems.	Evolving
Self-Powering (Harvesters)			
CSIRO	Flexible Integrated Energy Device	An energy harvesting system, a flexible battery, and washable fabric with conductive fibers that connect to other electronic devices.	Evolving
University of Waterloo	Metamaterial medium for electromagnetic	A metamaterial with 13 × 13 electrically small cells, each loaded with an 82 Ω resistor that mimics the input impedance of a rectification circuitry. The power	Evolving

[energy harvesting](#)

absorption is dissipated across a resistive load, which implies that effective electromagnetic energy harvesting can be achieved.

Power Supplies			
City University of Hong Kong	industrially weavable and knittable conductive yarns	Large energy storage textiles fabricated into a wrist band to form a pattern and enabling dual functionalities of energy storage capability and wearability.	Evolving
Stanford University	Flexible aluminum battery	The flexible aluminum battery charges in 1 minute and holds 2 volts and can be recharged thousands of times without capacity loss. The battery's incorporation of graphite allows for fast charge and discharge.	Evolving
University of California	Hybrid supercapacitor	High-energy, super-thin hybrid supercapacitor that can hold charge long enough to power the demo LED overnight. The device combines graphene and manganese dioxide for an energy density that can reportedly achieve up to 42-Watt-hours per liter and does not require dry rooms or extreme temperatures for production.	Evolving
Power Reduction			
Amtel	SAM L-21 microprocessor	A low-power, ARM-powered microprocessor with a 42Mhz Cortex CPU, 256KB of flash memory, 32KB of RAM and 8KB of low power RAM. It uses five modes of varying sleep levels to conserve energy.	Available
Toshiba	TZ1001MBG microcontroller	Low-power microcontroller addresses the need for a small battery and power control in wearable devices. The device reportedly delivers a 31% reduction in power consumption by better controlling the frequency of transition from multiple sensors.	Evolving
Communications			
Integrated Voice/Data/Video			
Soliton Systems K.K.	Zao smart-telecaster	Hardware encoder designed for mobile broadcasting and first responder markets. The telecaster delivers high-quality, real-time streaming video, adjusting the video compression ratios to offer quality transmission even in low-reception. It provides audio and video capability and supports 8 mobile channels.	Evolving
Short-range low-power Bluetooth			
MSA, Motorola	Integrated Bluetooth communications for self-contained breathing apparatus	Bluetooth and APX radio technology into self-contained breathing apparatus to enable firefighters to communicate more clearly in noisy environments. The microphone is integrated as part of the voice port of the regulator.	Available

Hands-Free Operation			
Makeroni	Eye of Horus 3D-printed, open-source platform	Horus uses sight to allow users to control devices hands-free.	Evolving
Other			
AWIRE	AWIRE two-way radio	Two-way radio that integrates with a smartphone. The technology comprises the AWIRE smartphone app, Bluetooth connectivity, UHF radio.	Evolving
Generator Research	Body Wifi	Body wi-fi, or wi-bo, would establish a single control device as the interface for the rest of the body network to provide a smooth connection of multiple wearables.	Evolving
Google	Android Wear	Communicates with a user's Android devices over wifi or cellular data connection, reducing the need for the user to have their phone nearby at all times	Evolving
Cameras			
DirectView Holdings Inc.	Body cameras	a next-generation body camera that will pair with its subscription cloud storage, and it will also feature an embedded fingerprint reader as well as Bluetooth, wi-fi and LTE connectivity.	Soon to be released
Exoskeletons			
Cadence Biomedical	Kickstart wearable neuro-rehabilitation device	Wearable neuro-rehabilitation device that accelerates walking recovery and functional improvements after injury. It features the "bio-inspired" Exotendon technology that is essentially an artificial tendon that assists with stability and movement.	Available
Carnegie Mellon University	Motor-free walking assistance device	Motor-free exoskeleton "hydraulic cast" straps on from the knee to ankle and can reportedly reduce the energy required to walk by 7 percent. Instead of a motor or power source, the device uses a spring that stores and releases energy and an innovative clutch that mimics calf muscles.	Evolving
Wearable Computers			
LG	Wearable smartphone	LG has patented a smartphone that can turn into a smartwatch. The proposed device would be flexible and with a magnet-closing strap bracelet.	Evolving
Samsung	Smartphone smartwatch	Samsung patented a flexible smartphone that doubles as a smartwatch. The device will reportedly feature a large, flexible, touchscreen OLED display.	Evolving
Other			
Cadence Design Systems Inc.	Fusion Digital Signal Processor (DSP)	Fusion DSP offers a configurable core, low-power consumption (25% less), and a small footprint fit for wearables. It features indoor navigation, context-aware	Evolving

		sensor fusion, secure local wireless connectivity, face trigger, voice trigger, and voice recognition functions.	
Dialog Semiconductor PLC	SmartBond DA14680 "Wearable-on-Chip"	A single-chip solution that reduces power consumption and form factor and offers Bluetooth Smart connectivity with wearables and smart home devices.	Evolving
Draper Laboratory	3D tracking wearable	Wearable device that will track astronauts' as they move around the International Space Station, providing data that can be used to create 3D models of the users' habitat to inform future designs	Evolving
Exist	Exist	Designed to make use of multitude of wearable data. Gathers data from users' existing services and can review a user's data over the past 90 days to identify and track trends or changes as well as to set new goals.	Available
Feelix	Feelix tactile bracelet	Bracelet syncs with a smartphone and alerts users through eight electro-tactile pads. The device helps a user interact with their surroundings.	Evolving
IBM	Watson Health Cloud	Provides multiple users (physicians, insurance companies, health practitioners, etc.) secured access to patient data. Intended to make use and share the growing amount of wearable data.	Available
Imagination	Enigma Whisper System on Chip wireless intellectual property	Low-power system-on-chip technology with a Bluetooth Low-Energy, Wi-fi, and combination model. Improves efficiency by saving metadata about the synchronization and decoding in order to take short cuts in synchronizing and decoding future packets.	Evolving
Johnson Space Center, Ministry of Supply	Apollo Shirt	Garments with phase-change materials to regulate body temperature	Available
Metarac	SecureIoT	This project is exploring the security of personal data gathered by wearable technology.	Evolving
Microsoft	Emotion detection	Patented emotion detection for wearables, such as augmented reality smart glasses. Tracks and assesses emotions by detection fluctuations in body temperature, tone, vocabulary, and facial expressions.	Evolving
Mission Ready Services Inc.	Next-Generation Body Armor System	Integrates protective modules into a lightweight upper extremity system to provide great protection.	Evolving
MIT Media Lab	NailO finger-mounted gestural input surface	multilayered miniaturized hardware affixes to a nail and transmits data via Bluetooth and allows a user to control devices via swipe gestures .	Evolving
Purdue University	Inkjet-printed liquid metal	Inkjet-printed liquid alloys to create elastic or flexible electronic circuits	Evolving
Raytheon	Boomerang Warrior-X wearable shooter	Wearable shooter detection system notifies users of fire attack and gives unit leaders a sniper's grid coordinates. The device comprises built-in earpieces	Evolving

Redpoint Positioning Corporation	detection system Redpoint real-time location system	and a wrist display. The device integrates with the Aviation Warrior System. High precision real-time location accuracy to within 8", a lightweight mesh infrastructure that can be battery powered and embedded into safety vests where it delivers visual and audible alerts.	Evolving
Rice University, David Eagleman (Individual)	Versatile Extra-Sensory Transducer (VEST)	A vest that interprets sound and translates it into vibrations that communicate to a user.	Evolving
Royal Phillips	CareSage predictive analytics engine	Combines data from wearable devices with predictive analytics to provide enhanced health monitoring	Evolving
Royal Phillips, Leiden University Medical Center	Wearable data analytics	Researchers will conduct trials to explore how to use wearable data analytics and algorithms to benefit preventative and chronic care.	Evolving
Ulm University	Belt	Features a grid of touch-sensitive studs that allow a user to control (scroll, select, etc.) their display wearable devices.	Evolving
Vasper	Vasper compression technology	Users "vascular performance" concentrating lactic acid buildup in the muscles to enable more efficient exercise. Users wear a cooling vest and compression sleeves while exercising for 20 minutes, followed by 10 minutes of decompression and cooling.	Available



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