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Responder Technology Alert Monthly (December 2014)

February 2015

JF Upton
SL Stein

U.S. DEPARTMENT OF
ENERGY

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Pacific Northwest National Laboratory
Richland, Washington 99352

Acronyms and Abbreviations

GPS   global positioning system

NFC   near-field communications

PNNL   Pacific Northwest National Laboratory

RFID   radiofrequency identification

RTA   Responder Technology Alliance

SLAM   Simultaneous Localization And Mapping

Contents

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.
- 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 areas 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 AGGIL Technologies: GRVTY

Technology name: GRVTY smart fitness band

Description: GRVTY detects changes in a user's motion and body position and uses algorithms to analyze whether the user is accidentally falling, and if so, GRVTY sends an alert to smart devices. The device is reported to detect dangerous motion patterns, texting while driving, weaving, etc. and in the case of a crash the device alerts the user's emergency contacts.

Status: Evolving

Funding: Crowdfunding

Product link: https://www.indiegogo.com/projects/grvty-wearable-detecting-fall-crash-text-driving

Source: *GRVTY: Wearable detecting fall, crash & text driving.*
https://www.indiegogo.com/projects/grvty-wearable-detecting-fall-crash-text-driving

Photo source: https://www.indiegogo.com/projects/grvty-wearable-detecting-fall-crash-text-driving

2.1.2 Biocompatible Adhesive Gel Patch

Technology name: Biocompatible adhesive gel patch

Description: Biomedical engineers in Japan developed a "biocompatible, flexible, adhesive gel patch that senses internal or external electrophysiological biological signals." The patch can hold up to 144 sensors placed 4 mm apart and employs an adhesive gel that holds the detectors in place even on a non-static surface such a limb or joint. The prototype demonstrated that the device "adheres to the wet, dynamic surface of heart muscle for more than 3 hours, facilitating the reliable measurement of biological signals."

Status: Evolving

Funding:

Product link:

Source: "Biocompatible Adhesive Gel Patch for Sensing and Monitoring EP Signals in Biological Tissues." *FOAM EM RSS.* http://www.foamem.com/author/iris-kulbatski/

2.1.3 Bioserenity: Wearable Epilepsy Monitoring Unit

Technology name: Wearable Epilepsy Monitoring Unit (WEMU)

Description: The device comprises a shirt and cap with embedded sensors that measure biometric data that are then transmitted to a smartphone, cloud system, and a patient's medical team and/or caretakers.

Status: Evolving

Funding:

Product link: http://www.bioserenity.com/en.html

Source: "Wearable Clothing to Help Epilepsy Patients." *Health Tech Insider.* http://healthtechinsider.com/2014/12/16/wearable-clothing-help-epilepsy-patients/

2.1.4 bOMDIC Inc.: GoMore

Technology name: GoMore

Description: GoMore is a "stamina sensor" employing patented technology that calculates physical capability by providing heart rate analysis and real-time readouts of performance including mileage, stamina, and calorie burn. Features include a heart-rate monitor, real-time alerts, workout map, and efficiency report. The device includes a GoMore sensor, adjustable chest-belt and 24-hour battery life.

Status: Soon to be released. Scheduled release date of April 15, 2015

Funding: Crowdfunding

Product link: http://www.gomore.me/

Source: "World's First Wearable Stamina Sensor And App Changes The Fitness And Health Landscape." *PR Newswire.* http://www.prnewswire.com/news-releases/worlds-first-wearable-stamina-sensor-and-app-changes-the-fitness-and-health-landscape-300013679.html

2.1.5 Cambridge Consultants: XelfieX

Technology name: XelfieX smart fabric

Description: XelfieX employs fiber-optic sensors and impulse radar to measure joint movement. Algorithms translate the sensor data, giving the user feedback on their posture and movement.

Status: Evolving

Funding:

Product link: http://www.cambridgeconsultants.com/media/press-releases/innovation-wearable-tech

Source: "New wearable tech really is power dressing." *Business Weekly*. http://www.businessweekly.co.uk/hi-tech/17906-new-wearable-tech-really-is-power-dressing

2.1.6   Clevercare

Technology name: Clevercare medical alarm

Description: Clevercare is a wrist-worn medical alarm that connects patients and caregivers. The device can be used as a communications, alert, and GPS-tracking tool.

Status: Available only in New Zealand.

Funding:

Product link: http://clevercare.co.nz/

Source: "Wearable device with GPS tracking to provide clever care." *Pulse It*. http://www.pulseitmagazine.com.au/index.php?option=com_content&view=article&id=2210:wearable-device-with-gps-tracking-to-provide-clever-care&catid=49:new-zealand-ehealth&Itemid=329

2.1.7   Globe: Wearable Advanced Sensor Platform™

Technology name: Wearable Advanced Sensor Platform™ (WASP)

Description: The WASP shirt is equipped with physiological sensors mounted on adjustable straps on a moisture-wicking, flame-resistant shirt. A TRX location unit provides indoor location data in 3D in GPS-denied environments while a Zephyr BioHarness™ 3 electronic module tracks heart rate, heart rate variability, respiration rate, activity levels, posture, and other physiological factors. According to the developer web site, "WASP provides a tool for incident commanders to track the location of team members to improve situational awareness and potentially shorten the time needed for a RIT team to rescue a downed firefighter."

Status: Evolving

Funding:

Product link: http://www.globeturnoutgear.com/innovations/wasp

Source: *Globe Turnout Gear*. http://www.globeturnoutgear.com/innovations/wasp

Photo source: http://www.globeturnoutgear.com/innovations/wasp

2.1.8 Intel, Michael J. Fox Foundation for Parkinson's Research

Technology name: Wearable technologies to monitor Parkinson's symptoms

Description: The Michael J. Fox Foundation for Parkinson's Research and Intel Corporation are evaluating the use of wearables for tracking physiological features associated with Parkinson's. The developing technology will detect, analyze, and transmit to the cloud mobility patterns in people with Parkinson's disease. According to the Intel press release, scientists are "correlating the data collected to clinical observations and patient diaries to gauge the devices' accuracy, and are developing algorithms to measure symptoms and disease progression."

Status: Evolving

Funding:

Product link: http://newsroom.intel.com/community/intel_newsroom/blog/2014/08/13/the-michael-j-fox-foundation-and-intel-join-forces-to-improve-parkinsons-disease-monitoring-and-treatment-through-advanced-technologies

Source: "Wearable technology is breakthrough for Parkinson's." *Israel21c.*
http://www.israel21c.org/headlines/wearable-technology-is-breakthrough-for-parkinsons/

2.1.9 Jins Meme

Technology name: Smart glasses

Description: Smart glasses track eye movement to assess fatigue. The system uses three electrooculography sensors, placed in the frame and nose pads, to measure eye movement and blinking by tracking the retina. The company is exploring applications including "games where eyes would act as the controller, functions to measure interest levels, focus-training exercises and potentially tools to tackle neurodegenerative diseases."

Status: Evolving – anticipated to US market in 2015

Funding:

Product link: https://www.jins-jp.com/jinsmeme/en/

Source: "Jins Meme smart glasses have one eye on fatigue levels." *Gizmag*. http://www.gizmag.com/jins-meme-smart-glasses-energy-levels/35317/
Product link: https://www.jins-jp.com/jinsmeme/en/

2.1.10   Kenzen: ECHO™ H2

Technology name: ECHO™ H2 flexible biochemical sensor

Description: ECHO H2 uses a small, eco-friendly disposable patch to wirelessly analyze a user's sweat to measure hydration, lactic acid, and calories. The device comprises a "printed adhesive biochemical sensor" that communicates via low-energy Bluetooth to smart devices.

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

Funding: Crowdfunding

Product link: http://www.kenzenwear.com/

Source: "Kenzen Wearable Optimizes Athletic Performance with Real-Time Hydration, Lactic Acid and Glucose Analysis." *PR Newswire.* http://www.prnewswire.com/news-releases/kenzen-wearable-optimizes-athletic-performance-with-real-time-hydration-lactic-acid-and-glucose-analysis-300005504.html

2.1.11   Li Cheng-Yuan, and You Chuang-Wen, National Taiwan University (Individuals): NinjaFlex

Technology name: NinjaFlex smart bandage

Description: NinjaFlex is a soft 3-D-printer filament, bandage-like material that the National Taiwan University paired with medical sensors that monitor a patient's vital signs and can transmit the data to a patient's medical team using a smartphone or tablet.

Status: Evolving

Funding:

Product link: http://www.ninjaflex3d.com/

Source: "Forget Band-Aid… Here's 'NinjaFlex.'" *Wall Street Daily.* http://www.wallstreetdaily.com/2014/12/17/ninjaflex-smart-bandage/

Photo source: http://www.wallstreetdaily.com/2014/12/17/ninjaflex-smart-bandage/

2.1.12   LifeWatch, Vital Connect: Vital Signs Patch

Technology name: Vital Signs Patch cardiac telemetry

Description: Vital Signs Patch is a disposable, adhesive, remote cardiac monitoring chest-worn patch that monitors ECG, Heart Rate, respiration rate, surface temperature, and arterial blood oxygen saturation, and also acts as a wireless blood pressure cuff, with an estimated 5-7 day battery life. The device recently received FDA 510(k) clearance. Anticipated applications include, "The patch is immediately applied at the emergency site to capture, analyze and transmit relevant medical data to the hospital."

Status: Soon to be released - expected to launch in late 2015.

Funding:

Product link: http://www.lifewatch.com/

Source: "LifeWatch gets FDA clearance for adhesive, remote patient monitoring wearable." *Mobile Health News.* http://mobihealthnews.com/39243/lifewatch-gets-fda-clearance-for-adhesive-remote-patient-monitoring-wearable/

Vital Connect's HealthPatch, which partnered with LifeWatch last month

Photo source: http://mobihealthnews.com/wp-content/uploads/2014/05/Vital-Connect-HeartPatch.jpg

2.1.13   RipCurl: Search GPS

Source: "Rip Curl Surf Watch Review: The Most Advanced Waveproof Wearable Yet." *Gizmodo India.* http://www.gizmodo.in/gadgets/Rip-Curl-Surf-Watch-Review-The-Most-Advanced-Waveproof-Wearable-Yet/articleshow/45484066.cms

Product link: http://searchgps.ripcurl.com/welcome/

Technology name: Search GPS smartwatch

Description: This GPS-equipped, water-proof (to 330 feet) wristwatch monitors wave counts and speeds, tracks 1,360 tide locations, and provides notifications to the user. The data can also be used to generate a plot layered on Google Maps satellite image to analyze performance.

Status: Available

Funding:

2.1.14   Seoul National University

Technology name: Mechanical sensors

Description: Researchers of Seoul National University are designing a "highly sensitive, durable and flexible spider-inspired mechanical sensors [that] can detect and record music, recognize speech patterns, and monitor heart rates. The researchers are producing a platinum film based on a spider's "crack-shaped slit organs" that detect minute vibrations. The highly sensitive device "is reversible, reproducible, durable and mechanically flexible, and can thus be easily mounted on human skin as an electronic multipixel array."

Status: Evolving

Funding:

Product link: http://nature.com/articles/doi:10.1038/nature14002

Source: "Scientists Built a Wearable Sensor Pack Based on Spider Senses." *Business Insider Australia.* http://www.businessinsider.com.au/a-wearable-sensor-pack-based-on-spider-senses-2014-12

2.1.15   Spire

Technology name: Spire sensor clip

Description: Spire clips onto a user's garments worn close to the body and tracks breathing patterns to measure and notify a user of his/her focus, tension, calm, and activity.

Status: Available

Funding:

Product link: https://spire.io/

Source: "This Gadget Hooks Onto Your Underwear and Helps You Chill Out." *The Huffington Post.* http://www.huffingtonpost.com/2014/12/16/spire-wearable_n_6329888.html

2.1.16   University of Massachusetts Amherst, GE

Technology name: Patch to measure biomarkers in sweat

Description: Nano-Bio Manufacturing Consortium (backed by U.S. Air Force Research Laboratory) selected a proposal by the University of Massachusetts, Amherst, to develop a wearable sensor patch that monitors chemicals in the user's sweat to indicate stress and fatigue. The system targets Orexin-A, "a naturally occurring neuropeptide hormone released by the hypothalamus, and plays a crucial role in the stability of arousal and alertness." According to the NMBC press release, the technology demonstrated detection of Orexin-A from blood and saliva samples and offers the "lowest-risk system integration."

Status: Evolving

Funding: Awarded $450,000 funding – 50% from NBMC's U.S. Air Force Research Laboratory funds and 50% will be contributed by the winning team of UMass Amherst and its industrial partner, GE.

Product link: http://www.nbmc.org/nano-bio-manufacturing-consortium-selects-wearable-sensor-patch-subsystem-project-as-first-to-receive-funding/

Source: "Cheap, Disposable Biometric Patch to Monitor Stress and Fatigue in Military Personnel May Be Adapted to Monitor Biomarkers Used by Clinical Pathology Laboratories." *Dark Daily*. http://www.darkdaily.com/cheap-disposable-biometric-patch-to-monitor-stress-and-fatigue-in-military-personnel-may-be-adapted-to-monitor-biomarkers-used-by-clinical-pathology-laboratories-1210#axzz3Py16G6zZ

2.1.17   UC Berkeley

Technology name: Pulse oximeter sensor

Description: This organic-based wearable tracks blood-oxygen levels and measures pulse rate. Berkeley researchers describe the technology as using "light-emitting diodes (LEDs) to send red and infrared light through a fingertip or earlobe. Sensors detect how much light makes it through to the other side. Bright, oxygen-rich blood absorbs more infrared light, while the darker hues of oxygen-poor blood absorb more red light. The ratio of the two wavelengths reveals how much oxygen is in the blood."

Status: Evolving

Funding: National Science Foundation and Flextech helped support this research

Product link:

Source: "Organic electronics could lead to cheap, wearable medical sensors." *UC Berkeley News Center*. http://newscenter.berkeley.edu/2014/12/10/organic-electronics-cheap-wearable-medical-sensors/
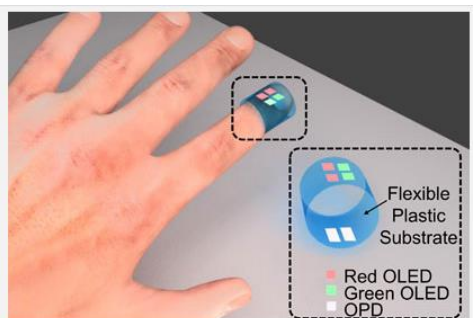
UC Berkeley engineers have created a pulse oximeter sensor composed of all-organic optoelectronics that uses red and green light. The red and green organic light-emitting diodes (OLED) are detected by the organic photodiode (OPD). The device measures arterial oxygen saturation and heart rate as accurately as conventional, silicon-based pulse oximeters. (Image by Yasser Khan)

Photo source: http://newscenter.berkeley.edu/2014/12/10/organic-electronics-cheap-wearable-medical-sensors/

2.1.18   U-Wake

Technology name: U-Wake headband

Description: The U-Wake headband uses EEG sensors to monitor brainwaves and analyze fatigue level because "brainwaves of a sleeping person are different from the brainwaves of a person who is awake." The device communicates to a smartphone app via Bluetooth.

Status: Evolving

Funding: Crowdfunding

Product link: http://u-wake.com/

Source: "Wake Up! Wearable Biomonitor Keeps You Safer While Driving." *PSFK*. at http://www.psfk.com/2014/12/biomonitor-aimed-at-driver-safety.html

Photo source: https://www.kickstarter.com/projects/441115504/u-wake-your-guardian-angel-for-road-safety

2.1.19   VivaLnk: eSkin™ Thermometer

Technology name: eSkin™ Thermometer

Description: eSkin™ uses electronic circuitry with embedded sensors on a thin, flexible material that comfortably adhere to the skin to measure temperature. The device employs a near-field communications (NFC) chip from NXP Semiconductors, does not require a battery, and transmits information to a smartphone app for "record keeping and alert function."

Status: Evolving

Funding: A limited number of samples will be available for interested partners in January 2015.
Product link: http://www.vivalnk.com/

Source: "VivaLnk Showcases New Wearable Thermometer Patch Based on Breakthrough eSkin™ Technology at CES." http://www.vivalnk.com/vivalnk-showcases-new-wearable-thermometer-patch-based-breakthrough-eskintm-technology-ces/

2.1.20   WiseWear: Evolve™

Technology name: Evolve

Description: Evolve uses the Nomad core sensor platform in a chest strap, shirt clip, or wristband to track heart rate, respiration, motion, global movement, galvanic skin response, and blood oxygenation and transmitted to a mobile device. The system employs predictive algorithms and analytics to interpret the data.

Status: Soon to be released – anticipated 4th quarter of 2015

Funding: Crowdfunding

Product link: http://wisewear.com/

Source: *WiseWear Evolve: Wearable 2.0 Sensor Platform.*
https://www.indiegogo.com/projects/wisewear-evolve-wearable-2-0-sensor-platform

Photo source: https://www.indiegogo.com/projects/wisewear-evolve-all-in-one-health-tracker
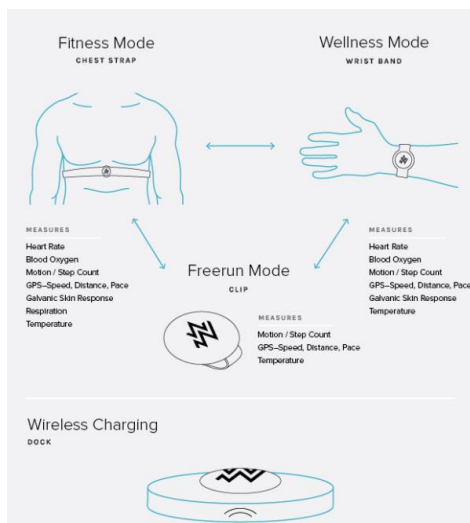
2.2 Chemical/Particulate

2.2.1 Breathe

Technology name: Breathe

Description: Breathe employs air quality sensors in a wearable clip to measure toxic elements in the air and report a user's air pollution readings to crowdsourced dataset. The device can also send air pollution alerts to a user's smartphone.

Status: Evolving

Funding:

Product link: http://breathe.city/

Source: "Wearable air quality monitor crowdsources pollution data." *Springwise*. http://www.springwise.com/wearable-air-quality-monitor-crowdsources-pollution-data/

Photo source: http://breathe.city/

2.2.2   Wepo

Technology name: Wepo air pollution monitor

Description: Wepo is a wearable pollution-exposure-monitoring device equipped with an electrochemical carbon monoxide sensor. Future iterations are expected to measure nitrogen dioxide, particulate matter and other pollutants. The device features a 20-hour battery life and communicates with phone apps to interpret the air pollution data.

Status: Evolving

Funding: Crowdfunding – surpassed target

Product link: https://www.indiegogo.com/projects/wepo-for-people-who-watch-air

Source: "Wepo is a Crowdfunded Wearable for Air Quality Monitoring." *NDTV Gadgets.* http://gadgets.ndtv.com/wearables/news/wepo-is-a-crowdfunded-wearable-for-air-quality-monitoring-639560

Photo source: https://www.indiegogo.com/projects/wepo-for-people-who-watch-air

2.3 Other

2.3.1 First Sign, MaceWear: Pod

Technology name: 5-in-1 Pod automatic personal security system

Description: The Pod provides "advanced software and sensors to automatically detect many violent assaults or medical emergencies." The device attaches to common devices such as a keychain, belt clip, wristband, pendant or headband, and serves as an assault alert, fall alert, and panic button. Depending on where it is worn, it can detect when a user suffers a blow or administers a self-defense maneuver, for example. It collects "evidence" (location, what happened, photographs) and blares and alarm.

Status: Available

Funding:

Product link: http://www.firstsign.us/

Source: "First Sign and MaceWear Launch Pod: the Crime-Fighting Wearable." *Wearable World News.* http://wearableworldnews.com/2014/12/09/first-sign-macewear-launch-pod-crime-fighting-wearable/

Photo source: http://www.firstsign.us/products/#/pod/

2.3.2 Pauline van Dongen and TU Eindhoven & Textile Museum: Vigour

Technology name: Vigour clothing for rehabilitation and physical therapy

Description: Vigour clothing, with knit stretch sensors, was designed by Pauline van Dongen and TU Eindhoven & Textile Museum to track a user's movements and make the data available to a mobile app for use by the patient, therapist, caretakers, etc., with intended applications in rehabilitation and physical therapy.

Status: Evolving

Funding:

Product link: http://paulinevandongen.nl/news/vigour/

Source: "Vigour Wearable Tech For Rehabilitation & Physical Therapy." *Ubergizmo.*
http://www.ubergizmo.com/2014/12/vigour-wearable-tech-for-rehabilitation-physical-therapy/

2.3.3   ReTiSense: Stridalyzer

Technology name: Stridalyzer smart insoles

Description: Stridalyzer uses insoles equipped with patent-pending technology of multiple sensors that communicate stride information to a smart device. The device is intended to help users collect data about motion dynamics (stride, foot landing, etc.) and interpret the information with cloud-based analytics.

Status: Soon to be released

Funding: Crowdfunding

Product link: http://www.retisense.com/

Source: "Stridalyzer: World's First Wearable Product to Predict Knee Injury Risk, Live on Kickstarter."
PRWeb. http://www.prweb.com/releases/2014/12/prweb12395982.htm

2.3.4   Torch

Technology name: Torch

Description: Torch uses infrared sensors worn on the head or chest that emit an audible or vibrating warning when the user approaches an obstacle.

Status: Evolving

Funding:

Product link:

Source: "Wearable Sensor 'Illuminates' Surroundings for the Blind." http://on.aol.com/video/wearable-sensor-illuminates-surroundings-for-the-blind-518553057?playlist=165852&hp=1

2.3.5   Triax SIM-P

Source:"Triax SIM-P: Smart Wearable Monitors Head Impact." *iPhoneness.*
http://www.iphoneness.com/cool-finds/triax-sim-p/

Product link: https://www.triaxtec.com/sim-p/

Technology name: Triax SIM-P head band

Description: Triax SIM-P fits into a headband or cap and measures G-force of head impacts and sends alerts to smart devices.

Status: Available

Funding:

Photo source: http://www.iphoneness.com/cool-finds/triax-sim-p/

3.0 Displays

3.1 Heads-up (on face or head)

3.1.1 Intel, Luxottica Group

Technology name: Smart sports eyewear

Description: Intel Corporation and Luxottica Group S.p.A announced a multiyear collaboration to "fuse premium, luxury and sports eyewear with smart technology."

Status: Evolving – first product expected to launch in 2015

Funding:

Product link:

Source: "Intel and Luxottica Group Announce Multiyear Collaboration for Wearable Tech." http://newsroom.intel.com/community/intel_newsroom/blog/2014/12/03/intel-and-luxottica-group-announce-multiyear-collaboration-for-wearable-tech

3.1.2 Microsoft

Technology name: Virtual reality headset

Description: In line with Sony's Project Morpheus and Oculus Rift, Microsoft is anticipated to unveil a virtual reality headset at the E3 conference in June 2015.

Status: Evolving – anticipated in 2015

Funding:

Product link:

Source: "Microsoft's working on a wearable VR headset!" *The Gadget Show.* http://gadgetshow.channel5.com/news/microsoft%E2%80%99s-working-wearable-vr-headset

3.1.3 Oculus VR

Technology name: Oculus virtual reality (VR)

Description: Oculus announced three acquisitions/partnerships: Nimble VR, 13th Lab, and Chris Bregler, motion expert, to "the best and brightest in the space to solve some of the hardest vision challenges facing [virtual reality]." Nimble VR has been working on "high-quality, low-latency skeletal hand tracking," and "machine learning and computer vision capabilities." 13th Lab has been developing "real-time 3D reconstructions" of real-world sights. Bregler has been focused on visual tracking.

Status:

Funding:

Product link: https://www.oculus.com/blog/nimble-vr-13th-lab-and-chris-bregler-join-oculus/

Source: "Oculus VR Buys Hand-Tracking, 3D-Modeling Firms." *PCMag UK.*
http://uk.pcmag.com/wearable-tech/38211/news/oculus-vr-buys-hand-tracking-3d-modeling-firms

3.1.4   Osterhout Design Group

Technology name: Smart glass platform

Description: Osterhout is developing a "smart-glass platform capable of running full Android tablet software and extraordinarily crisp optics, which seem to float in front of the users' eyes even though the lenses on the glasses are clear."

Status: Soon to be available – expected to ship next year

Funding: Osterhout has reportedly invested about $60 million.

Product link: http://www.osterhoutgroup.com/company

Source: "Business puts on its wearables: Techies see limitless potential in data-rich gadgets." *Upstart Business Journal.* http://upstart.bizjournals.com/companies/innovation/2014/12/07/wearable-tech-google-glasses-pebble-watch-myo.html?page=all

3.1.5   Sony: Single-Lens Display Module

Technology name: Single-Lens Display Module

Description: According to the Sony blog, the module "turns eyewear into a smart device capable of displaying visual information" via a high-resolution color OLED microdisplay and miniaturized control board. The device beams the visual onto the user's glasses.

Status: Evolving – anticipated to be mass producing the module in the coming year

Funding:

Product link: http://www.sony.net/SonyInfo/News/Press/201412/14-118E/index.html

Source: "Sony concept eyewear tech turns your existing specs into smartglasses." *CNET.*
http://www.cnet.com/news/sony-concept-eyewear-tech-turns-your-existing-specs-into-smartglasses/

Control Board
• Processor
• Sensor Hub
• Wireless LAN
• Bluetooth

OLED Microdisplay

Optical Unit

Single-Lens Display Module (experimental)
(Left side of image: Display arm; Right side of image: Secondary arm incorporating the battery, etc.)

(Top) Sample field of vision;
(Bottom) Module attached to eyewear piece

Sony

Photo source: http://www.sony.net/SonyInfo/News/Press/201412/14-118E/index.html

3.2   Body-worn (wrist, arm, or chest)

3.2.1   Honeywell

Technology name: Wearable Solution for the Dolphin 70e Mobile Computer

Description: The device is a "hands-free, wrist-mounted version of the Dolphin 70e Black mobile device" intended to support warehouse operations. The device includes a large display and flexible touchscreen keypad.

Status: Soon to be released – anticipated to begin shipping in Asia Pacific in December.

Funding:

Product link: https://www.honeywellaidc.com/en-us/Pages/Product.aspx?category=wearable-scanner-and-mobile-computer&cat=HSM&pid=wearablesolution

Source: "Transforming DC operations with new technology." *Transport and Logistics News*. http://www.tandlnews.com.au/2014/12/04/article/transforming-dc-operations-new-technology/

Photo source: http://www.tandlnews.com.au/2014/12/04/article/transforming-dc-operations-new-technology/data-capture-honeywell-wearable-device/

3.2.2   Google, Intel: Google Glass v2

Technology name: Google Glass

Description: This article explores the possibilities of Intel being integrated into the upcoming iteration of Google Glass, in particular "divorcing advanced processing of things like speech from the cloud, and instead making such functionality self-contained" as well as "less reliance on a wireless connection and less time with the power-hungry screen."

Status: Evolving

Funding:

Product link:

Source: "Here's why Intel makes perfect sense for Google Glass v2." *Slash Gear.*
http://www.slashgear.com/heres-why-intel-makes-perfect-sense-for-google-glass-v2-01357860/

4.0 Power

4.1 Chargers

4.1.1 SolarHug

Technology name: SolarHug bracelet

Description: SolarHug is a bracelet that transforms solar energy into power for a smartphone or other devices via USB.

Status: Evolving

Funding: Crowdfunding

Product link: http://solarhug.com/

Source: "SolarHug Bracelet – Wearable Solar Charger." *Energy Matters*.
http://www.energymatters.com.au/renewable-news/solarhug-bracelet-charger-em4615/

Photo source: https://www.kickstarter.com/projects/1609919685/solarhug-bracelet-external-charger-powered-by-the

4.2 Self-powering (Harvesters)

4.2.1 Lanzhou University, Chinese Academy of Sciences

Technology name: Wearable triboelectric generator

Description: Researchers with the Lanzhou University and Chinese Academy of Sciences are designing a "cloth-based wearable triboelectric nanogenerator made of nylon and Dacron fabric" that harvests body motion energy. For example, the device "can turn the mechanical energy of [an] arm swing into electric energy and power an electroluminescent tube-like lamp easily." The device can output up to 0.2 mA and 2 kV and be handled like a normal garment.

Status: Evolving

Funding: Support from the NSFC, Fok Ying Tung education foundation, and Fundamental Research Funds for the Central Universities.

Product link:

Source: Cui N, J Liu, L Gu, S Bai, X Chen, and Y Qin. 2014. "Wearable Triboelectric Generator for Powering the Portable Electronic Devices." *ACS Applied Materials & Interfaces.* Accessed January 26, 2015 at http://pubs.acs.org/doi/pdfplus/10.1021/am5071688

4.2.2   Natick Soldier Research, Development, and Engineering Center

Technology name: Soldier-worn power sources

Description: Researchers are exploring portable, energy-harvesting technologies to reduce the need for soldiers to carry extra batteries. These devices capture "small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement" to recharge or power devices (communication equipment, sensors, displays). Researchers demonstrated the concept in April, including MC-10's photovoltaic wearable Solar Panel, Harvester Bionic Power's Knee Harvester, and the Lightning Pack's Rucksack. The device is "capable of producing 16 to 22 watts while walking, and 22 to 40 watts while running."

Status: Evolving – prototype was tested at Maneuver Fires Integration Experiment (MFIX) in September 2014

Funding:

Product link:

Source: "Soldiers of the Future to Self-generate Power." *Armed with Science: The Official U.S. Defense Department Science Blog.* http://science.dodlive.mil/2014/12/22/soldiers-of-the-future-to-self-generate-power/

4.2.3   Texas Instruments

Technology name: Harvesting technology

Description: Texas Instruments is developing electronics that turn small amounts of power generated by harvested sources into useful power sources. Texas Instruments demonstrating the ability to draw energy from the human body through vibration collectors or other harvesters the size of a wristband.

Status: Evolving

Funding:

Product link: http://www.ti.com/

Source: "Texas Instruments builds an alternative energy for the Internet of Things" *Computer World.* http://www.computerworld.com/article/2861863/texas-instruments-builds-an-alternative-energy-for-the-internet-of-things.html
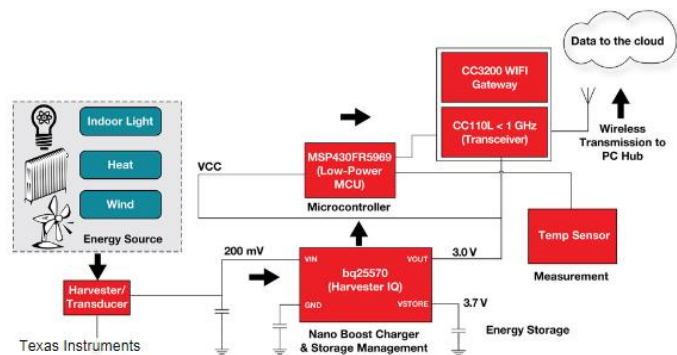
The diagram shows how Texas Instrument's wireless sensor network would work.

Photo source: http://www.computerworld.com/article/2861863/texas-instruments-builds-an-alternative-energy-for-the-internet-of-things.html

4.3 Power supplies

4.3.1 Fujitsu Laboratories Ltd.

Technology name: Middleware

Description: Fujitsu Laboratories is developing sensing middleware that will "simplify development of low-power sensing applications," by essentially intercepting requests for notification from applications, thus reducing the power drain on wearables and reducing the customizing work and associated development cycles and costs. The technology "cuts the amount of work required to build solutions that use sensing by 90%, while reducing power requirements by more than two-thirds."

Status: Evolving – aiming for implementation during fiscal 2015.

Funding:

Product link: http://www.fujitsu.com/us/products/software/middleware/

Source: "Fujitsu laboratories develops sensing middleware to simplify development of low-power sensing applications." *Phys.org*. http://phys.org/news/2014-12-fujitsu-laboratories-middleware-low-power-applications.html
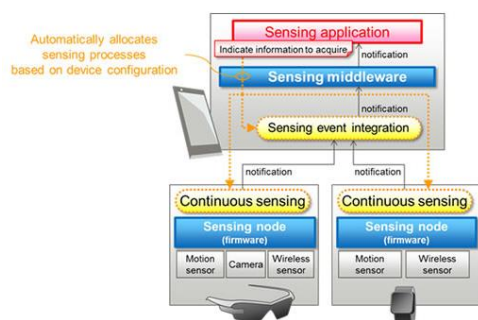
Figure 2: Overview of sensing application development framework

Photo source: http://phys.org/news/2014-12-fujitsu-laboratories-middleware-low-power-applications.html

5.0 Communications

5.1 Integrated voice/data/video

5.1.1 Telepathy Inc.: Jumper

Technology name: Jumper

Description: Jumper is a neck-worn and eye-worn device that features an optical display, camera, microphone, and sensors and is planned to have two applications, Eye Connect and Talent Buzz, that allow the user to share their field of vision and other information with others.

Status: Soon to be available – expected to go on sale in summer of 2015

Funding:

Product link: http://tele-pathy.org/eng/product/index.php

Source: "Presenting 'Telepathy Jumper,' a wearable device that alters how people communicate by sharing experiences." *PRNewswire.* http://www.prnewswire.com/news-releases/presenting-telepathy-jumper-a-wearable-device-that-alters-how-people-communicate-by-sharing-experiences-300013429.html

Photo source: http://www.telepathywear.com/product/index.php

5.2 Short-range low-power Bluetooth

5.2.1 Alpha: NFC ring

Technology name: Titanium near-field communication (NFC) ring

Description: This NFC ring communicates with other NFC devices, allowing the user to unlock NFC-enabled doors, communicate with NFC-enabled phones, and transfer information. It features open-source software allowing users to customize their experience.

Status: Available

Funding:

Product link: http://store.nfcring.com/products/alpha-signature

Source: "Alpha Titanium NFC Ring." *Cool Wearable.* http://www.coolwearable.com/alpha-titanium-nfc-ring/

5.2.2   Caseco: Blu-Toque

Technology name: Blu-Toque dual-layered Bluetooth hat

Description: Blu-Toque is a beanie (hat) equipped with Bluetooth technology that allows the user to take calls, listen to music, etc. wirelessly and without headphones. The device has a 10-meter range and charges in 2 hours for a 6-hour battery life.

Status: Available

Funding:

Product link: http://www.caseco.ca/product/blu-toque/

Source: *Caseco Blu-Toque*. http://www.caseco.ca/product/blu-toque/

5.3 Hands-Free Operations

5.3.1   Fin

Technology name: Fin thumb ring

Description: Fin is a smart thumb ring that utilizes Bluetooth and allows the user to engage with smart devices and appliances to share information and communicate.

Status:

Funding: Crowdfunding

Product link: http://mydreamistechnology.blogspot.com/2014/12/Fin-advanced-thumb-wearable.html

Source: "Fin advanced gesture-based thumb wearable." http://vimeo.com/114437753

Photo source: http://mydreamistechnology.blogspot.com/2014/12/Fin-advanced-thumb-wearable.html

5.3.2   Fullpower

Technology name: MotionX Sensor-Fusion technology

Description: Fullpower® was awarded a patent (8,902,154) for motion and gesture control in wearable devices, supplementing the company's MotionX Sensor-Fusion technology. Fullpower's MotionX® and Sleeptracker® technologies are featured in leading wearable devices including Nike and Jawbone.

Status: Available

Funding:

Product link: http://www.fullpower.com/

Source: "Fullpower Awarded Motion and Gesture Control Patent Critical for Wearable Devices." http://fullpower.com/news/2014/fullpower-awarded-motion-and-gesture-control-patent-critical-for-wearable-devices/

5.3.3   Institute for Integrative Nanosciences, Institute for Solid State and Materials Research Dresden, et al.

Technology name: Flexible magnetic field sensors

Description: Researchers are developing flexible bismuth Hall sensors that can bend around the wrist or be positioned on the finger, with only a minor reduction in sensor performance, and create an interactive pointing device for wearable devices.

Status: Evolving

Funding: Financed in part by the German Research Foundation DFG, BMBF project Nanett, and European Research Council within the European's Seventh Framework Program

Product link:

Source: "Wearable Magnetic Field Sensors for Flexible Electronics." *Advanced Materials.* http://onlinelibrary.wiley.com/doi/10.1002/adma.201405027/abstract

Photo source: http://onlinelibrary.wiley.com/doi/10.1002/adma.201405027/pdf
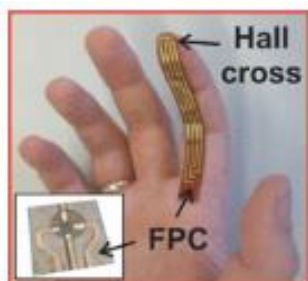
6.0 Exoskeletons

6.1.1 Argo

Technology name: Kineseowear, Ouijaband, LaLaLa

Description: This article explores upcoming technologies and advances in the areas of wearable technology available by Argo. For example, Kineseowear delivers cues to the wearer and resembles "a cross between a pair of suspenders and a small backpack and uses physical pressure to act as physical cues to action;" the Ouijaband uses a gyroscope and high RPM flywheels to steady a user's hand or grip; and Argo's LaLaLa uses a camera, microphone, Bluetooth, and gesture recognition to help the user focus in on what they want to (or do not want to) hear or see.

Status: Evolving

Funding:

Product link: http://www.argodesign.com/wearables.html

Source: "New Wearable Technology: 'Extra Muscles For Better Performance.'" *Agriculture*. http://www.agriculture.com/news/technology/new-wearable-technology-extra-muscles-f_6-ar46554

Photo source: http://www.argodesign.com/wearables.html

6.1.2 Daewoo Shipbuilding and Marine Engineering

Technology name: Robotic suit

Description: Daewoo is testing exoskeleton suits of light-weight aluminum alloy and steel, with straps at the feet, thigh, waist, and chest, and comprising hydraulic joints and electric motors connected to a backpack that powers the robotic suit. The suit is reported to "help workers lift up to 30kg, but the creators believe that they can increase that to a potential 100kg."

Status: Evolving

Funding:

Product link: http://www.dsme.co.kr/epub/main/index.do

Source: "Wearable robotics shows promise for heavy manufacturing." *EET India*.
http://www.eetindia.co.in/ART_8800707957_1800001_NT_71104356.HTM

6.1.3   Defense Advanced Research Projects Agency (DARPA): Airlegs

Technology name: Airlegs

Description: Airlegs are powered by a tank of compressed air connecting pulleys and electronic sensors to braces that essentially help pull the user's legs. The device currently reduces the user's load by 10 percent, with a goal to reach 25 percent.

Status: Evolving

Funding:

Product link: http://www.darpa.mil/default.aspx

Source: "An entire platoon wearing wearable robots." *CBS News.*
http://www.cbsnews.com/news/militarys-darpa-lab-creates-wearable-robot-to-help-soldiers-run-faster/

7.0 Wearable Computers

7.1.1 UK Home Office

Technology name: Police officer wearables

Description: This article explores how wearable technology is being considered to enhance police safety and operations. This includes body cameras, light-weight armor, graphene material, smart watches, digital glasses, and exoskeletons. The UK Minister for Organised Crime announced the launch of the Security Innovation Centre (SIDC) where scientists are "developing the digital police officer" to maximize capabilities of wearable technologies.

Status: Evolving

Funding:

Product link:

Source: "Robocops! How Google Glass, wearable computers and exoskeletons will turn the friendly neighbourhood bobby into a 'paramilitary' crime-fighting machine." *Daily Mail.* http://www.dailymail.co.uk/news/article-2875775/Robocops-Google-Glass-wearable-computers-exoskeletons-police-forces-wishlists-officers.html

Photo source: http://www.dailymail.co.uk/news/article-2875775/Robocops-Google-Glass-wearable-computers-exoskeletons-police-forces-wishlists-officers.html

8.0 Other

8.1.1 Canatu: Nanobud®

Technology name: Nanobuds

Description: Nanobud films are a "hybrid of Carbon Nanotubes and fullerenes" designed to conduct electricity while providing flexibility and durability fit for flexible and foldable devices. The flexible and transparent films can turn almost any surface into a touch-screen.

Status: Available

Funding:

Product link: http://www.canatu.com/nanobud/

Source: "Carbon 'nanobuds' could transform any surface into a touch screen or sensor." *International Business Times.* http://www.ibtimes.co.uk/carbon-nanobuds-could-transform-any-surface-into-touch-screen-sensor-1478515

8.1.2 DuPont Microcircuit Materials

Technology name: Stretchable electronic ink materials

Description: DuPont is producing "stretchable electronic ink materials" for use in wearables, including embedding comfortably and seamlessly into many standard fabrics. The stretchable inks are durable and washable (up to 100 wash cycles).

Status: Soon to be released – on display at recent industry events

Funding:

Product link: http://www.dupont.com/products-and-services/electronic-electrical-materials/printed-electronics/products/stetchable-inks-for-wearable-electronics.html

Source: "DuPont Intros Stretchable Inks for Wearable Electronics."*PCB007.* http://www.pcb007.com/pages/zone.cgi?a=105321
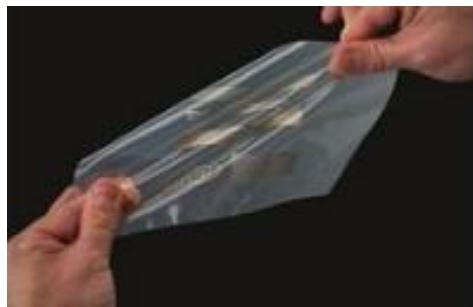

Photo source: http://www.dupont.com/products-and-services/electronic-electrical-materials/media/press-releases/20141204-stretchable-inks-for-wearable-electronics.html

8.1.3   Elliott Fight Dynamics: StrikeTec

Technology name: StrikeTec sensor

Description: StrikeTec is a wrist-worn device that can track punch speed, force, type, count, and more to help an athlete analyze their punch performance. The data is communicated to the StrikeTec Boxing Training App via Bluetooth.

Status: Evolving

Funding: Crowdfunding

Product link: http://efdstriketec.com/

Source: StrikeTec Sensor Brings Wearable Technology to Boxing." *Sport Techie.* http://www.sporttechie.com/2014/12/15/striketec-sensor-brings-wearable-technology-to-boxing/

8.1.4   Intel

Technology name: Real-time facial recognition system

Description: Intel filed an application (No. 20140341430, "Method and Device for Detecting Face, and Non-Transitory Computer-Readable Recording Medium for Executing the Method") to patent real-time facial detection using an image or video from a mobile device. The system breaks up the image into regions and conducts face detection and face tracking operations. Partitioning the images is reported to reduce the time required by portable devices to detect faces in real time.
Status: Evolving

Funding:

Product link: http://www.freepatentsonline.com/y2014/0341430.html

Source: "Intel files patent for real-time facial recognition system." *Biometric Update.* http://www.biometricupdate.com/201412/intel-files-patent-for-real-time-facial-recognition-system

8.1.5   Massachusetts Institute of Technology: Simultaneous Localization And Mapping

Technology name: Simultaneous Localization And Mapping (SLAM) systems

Description: SLAM is designed to enable first responders to generate real-time maps. The system incorporates different positioning technologies including GPS to track physical location, LIDAR to measure light pulses, Gyroscopes to adjust for tilt, accelerometers to measure speed, barometer to measure air pressure changes, and a camera. The device was intended to provide first responders with "the ability to generate real-time maps as they explore a location, the remote transmission of the spatial layout of a building can help external commanders the ability to better manage emergency situations."

Status: Evolving

Funding:

Product link: http://web.mit.edu/newsoffice/2012/automatic-building-mapping-0924.html

Source: "Portable Wearable Mapping System Powered by SLAM." *Geoawesomeness.*
http://geoawesomeness.com/portable-wearable-mapping-system-powered-by-slam/

Photo source: http://newsoffice.mit.edu/2012/automatic-building-mapping-0924
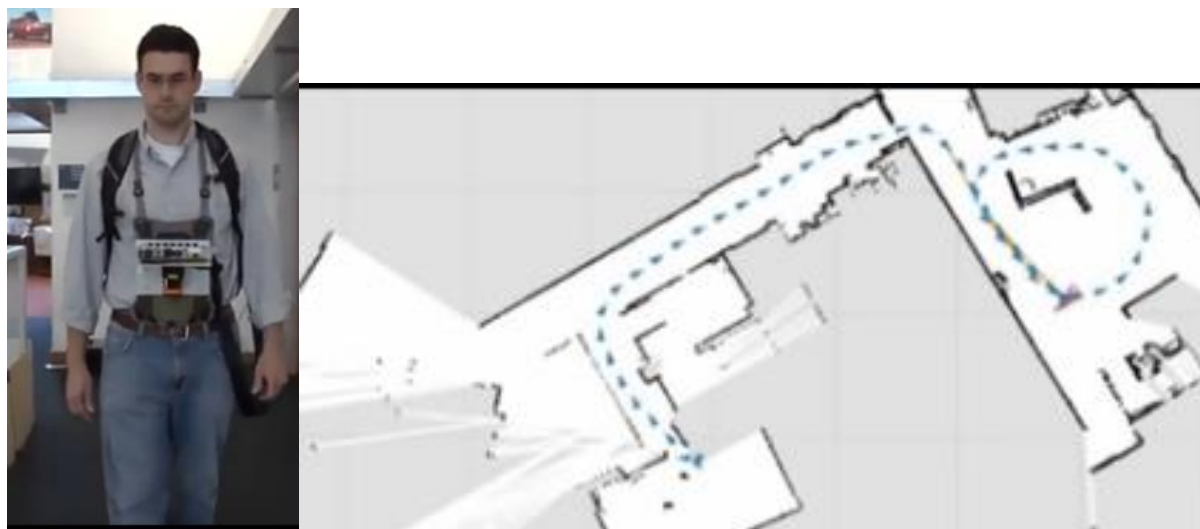
8.1.6   Massachusetts Institute of Technology, Stratasys

Technology name: 3D wearable skins

Description: Neri Oxman, director of the MIT Media Lab's Mediated Matter, and 3D printing company Stratasys are developing wearables "capable of keeping humans alive on other planets." The 3D "wearable skins" integrate engineered cells made by Stratasys's 3D printing technology and are designed to hold living matter while enabling a range of tasks from "producing and storing oxygen to absorbing nutrients and generating energy."

Status: Evolving

Funding:

Product link: http://neri.media.mit.edu/

Source: "An MIT Professor Is Creating 3D 'Wearable Skin' to Help You Survive Outer Space." *BostInno*.
http://bostinno.streetwise.co/2014/12/03/images-of-neri-oxmans-3d-wearable-skins-designed-for-outer-space/

8.1.7   Norton, Betabrand

Technology name: Radiofrequency identification (RFID)-blocking garments

Description: Norton and Betabrand have partnered to produce clothing that blocks unwanted wireless communications by blocking RFID and NFC transmissions. The machine-washable garments can shield credit cards from scanning devices while allowing cellular phone signals to pass through.

Status: Soon to be released – expected in February 2015

Funding:

Product link: http://www.betabrand.com/blog/33531/betabrand-norton-creates-worlds-first-rfid-blocking-jeans-blazer

Source: "Norton-Approved Security Pockets Guard Against Security Theft." *Wearable World News*. http://wearableworldnews.com/2014/12/18/norton-approved-security-pockets-guard-security-theft/

8.1.8   Performance Lab: ARDA Coaching Engine

Technology name: ARDA Coaching Engine

Description: The ARDA Coaching Engine patented software platform that "creates an accurate picture of performance by blending and interpreting multiple data streams." The device fuses sports science, coaching, and technology to allow the user to interpret and analyze data regarding geography, physiology, and history (terrain, weather, speed, power, recent performance, sleep and measures of fatigue), essentially "building a 360-degree real-time view of user activity."

Status: Soon to be released – expected early 2015

Funding:

Product link: http://performancelab.co.nz/

Source: "Real-Time, Responsive, Actionable Advice: ARDA Coaching Engine; a Breakthrough in Wearable Fitness Software." *BusinessWire.* https://uk.finance.yahoo.com/news/real-time-responsive-actionable-advice-140000079.html

8.1.9   Pinto

Technology name: Pinto storage wristband

Description: Pinto is a wrist-worn storage device that connects wirelessly via Bluetooth to devices, no internet required. It provides 32-64GB of storage space, wireless charging, and password protection.

Status: Evolving

Funding: Crowdfunding

Product link: http://www.beanbeam.com/

Source: "Pinto Bluetooth storage wearable puts files on your wrist." *Gizmag*.
http://www.gizmag.com/pinto-wireless-storage-wristband/35052/

Photo source: http://www.beanbeam.com/

8.1.10   Spansion, Sensoplex

Technology name: Wearable development platform

Description: Spansion and Sensoplex announced their partnership to produce an evaluation and development kit platform allowing customers to develop wearable applications that "combine inertial, bio and environmental sensors, Bluetooth Low Energy (BLE), and ANT+[1] wireless protocols with ultra low-power processing." The platform comprises microcontrollers with low-power management, flash memory, interface for wireless data communications, and more.

Status: Evolving

Funding:

Product link: http://news.spansion.com/2014-12-16-Spansion-and-Sensoplex-Launch-High-Performance-Low-Power-Wearable-Development-Platform

Source: "Spansion and Sensoplex Launch High-Performance, Low-Power Wearable Development Platform." *Market Watch.* http://www.marketwatch.com/story/spansion-and-sensoplex-launch-high-performance-low-power-wearable-development-platform-2014-12-16-718300

8.1.11   Strap

Technology name: Strap Metrics and Strap Kit

Description: The software development firm Strap has raised $1 million seed investments that it will invest in product development. The company is the creator of Strap Metrics and Strap Kit analytics platforms designed for wearable applications. Strap Kit is a platform development framework for wearables, currently for Pebble and Wear and anticipated Apple Watch and Samsung Gear in the future. Strap Metrics (currently in beta) is designed to integrate with Pebble to tell a user "who is using your app, when and where."

Status:

Funding: $1 million recently awarded in seed investments

Product link: https://www.straphq.com/

Source: "Wearable tech startup Strap raises $1.25M." *Cincinatti.*
http://www.cincinnati.com/story/money/2014/12/02/cincytech-invests-local-startup/19765717/

8.1.12 TUV Rheinland

Technology name: Smart wearable device certification

Description: TUV Rheinland has launched the world's first certification standard for wearable devices. A seminar was held that welcomed manufacturers to discuss safety requirements, testing, quality, data accuracy and more, relative to the development of wearables. The standards address requirements in safety, wearability, and smart functionality, as well as wireless connectivity, electromagnetic compatibility, and hazardous substance use.

Status: Available

Funding:

Product link: http://www.tuv.com/media/china/press_1/EN.jpg

Source: "TUV Rheinland Visions for Quality Wearable Devices."
http://www.tuv.com/news/en/greater_china/about_us_cn/press_3/pressreleases_gc_en/news_content_en_229120.html/wearables

8.1.13 University of Toronto Mississauga

Technology name: Player Tracking System

Description: The Player Tracking System app "tracks the location of players on a field and displays the data as a heat map." The system comprises a Moto360 watch worn by the player that communicates with an Onyx Beacon located on the field perimeter and ultimately uploaded to an IBM Bluemix server.

Status: Evolving

Funding: $7,500 cash prize awarded at the SportsHack event sponsored by IBM and We Are Wearables

Product link:

Source: "UTM team wins wearable sports tech competition." https://www.utm.utoronto.ca/main-news/utm-team-wins-wearable-sports-tech-competition

Photo source: https://www.utm.utoronto.ca/main-news/utm-team-wins-wearable-sports-tech-competition
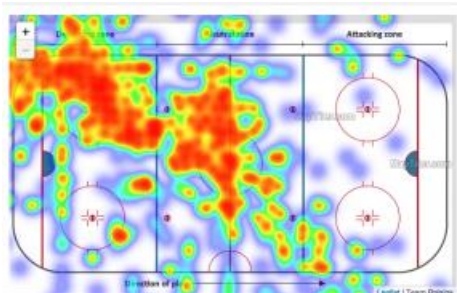
8.1.14   XOEye Technologies

Technology name:

Description: XOEye Technologies announced its commitment of $1.5 million in Series A funding in the wearables field. The 90-day funding round is co-led by Crestlight Ventures and Selous Venture Society. XOEye Technologies is a "leading enterprise wearables solutions company" that produces wearable technology for the industrial workplace, including operating systems for smart eyewear and other wearable platforms; hardware including ANSI-certified smartglasses with video, photo and two-way audio; and secure cloud-hosted software systems to manage wearable devices and interpret data.

Funding: $1.5 million in Series A funding

Product link: http://www.xoeye.com/blog

Source: "XOEye Technologies Announces $2 Million Series A Round to Fuel Hiring and Company Expansion in Enterprise Wearables Market." *Market Wired.* http://www.marketwired.com/press-release/xoeye-technologies-announces-2-million-series-a-round-fuel-hiring-company-expansion-1974706.htm

8.1.15   YESJ EXPERT, AYEIM: AYEFI

Technology name: AYEFI

Description: AYEFI is a GPS-equipped wearable designed for "safety, education, and entertainment." Users can use the device to notify others of their location. The device is also compatible with the user's smart phone.

Status: Soon to be available – expected February 2015

Funding:

Product link: http://www.ayefi.co/

Source: "AYEFI Launches Wearable, Smart-Safety Device." *PRNewswire.* http://www.prnewswire.com/news-releases/ayefi-launches-wearable-smart-safety-device-300008377.html

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			
AGGIL Technologies	GRVTY smart fitness band	Detects changes in a user's motion and body position and uses algorithms to analyze whether the user is accidentally falling, and if so, GRVTY sends an alert to smart devices.	Evolving
Biocompatible adhesive gel patch	Biocompatible adhesive gel patch	Small, flexible, adhesive patch that can holdas many as 144 physiological sensors	Evolving
Bioserenity	Wearable Epilepsy Monitoring Unit (WEMU)	Shirt and cap with embedded sensors that measure biometric data that are then transmitted to a smartphone, cloud system, and a patient's medical team and/or caretakers	Evolving
bOMDIC	GoMore	Stamina sensor that straps on and measures performance including mileage, stamina, and calorie burn	Soon to be released
Cambridge Consultants	Xelfiex smart fabric	fiber-optic sensors and impulse radar to measure joint movement and give users feedback on their posture and movement	Evolving
Clevercare	Clevercare medical alarm	Wrist-worn medical alarm that connects patients and caregivers	Available in New Zealand
Globe	Wearable Advanced Sensor Platform™ (WASP)	Moisture-wicking, flame-resistant shirt with a TRX location unit that provides indoor location data in 3D in GPS-denied environments while a Zephyr BioHarness™ 3 electronic module tracks heart rate, heart rate variability, respiration rate, activity levels, posture, and other physiological factors.	Evolving
Intel, Michael J. Fox Foundation for Parkinson's Research	Wearable technologies to monitor Parkinson's symptoms	Technology that will technology will detect, analyze, and transmit to the cloud mobility patterns in people with Parkinson's disease	Evolving
Jins Meme	Smart glasses	Smart glasses that track eye movement to assess fatigue	Evolving
Kenzen	ECHO™ H2 flexible biochemical sensor	A small, eco-friendly disposable patch to wirelessly monitor a user's hydration, lactic acid, and calories.	Soon to be released

Li Cheng-Yuan, and You Chuang-Wen, National Taiwan University	NinjaFlex smart bandage	3-D-printer filament, bandage-like material paired with medical sensors that monitor a patient's vital signs and transmit the data to a patient's medical team using a smartphone or tablet.	Evolving
LifeWatch, Vital Connect	Vital Signs Patch cardiac telemetry	disposable, adhesive, remote cardiac monitoring chest-worn patch that monitors ECG, Heart Rate, respiration rate, surface temperature, and arterial blood oxygen saturation, and also acts as a wireless blood pressure cuff	Soon to be released
RipCurl	Search GPS smartwatch	GPS-equipped, water-proof (to 330 feet) wristwatch monitors wave counts and speeds, tracks 1,360 tide locations, and provides notifications to the user	Available
Seoul National University	Mechanical sensors	Platinum film based on a spider's crack-shaped slit organs that detect minute vibrations.	Evolving
Spire	Spire sensor clip	Clips onto a user's garments and tracks breathing patterns to measure and notify a user of his/her focus, tension, calm, and activity.	Available
U.S. Air Force Research Laboratory, University of Massachusetts Amherst, GE	Patch to measure biomarkers in sweat	Wearable sensor patch that monitors chemicals in the user's sweat to indicate stress and fatigue	Evolving
UC Berkeley	Pulse oximeter sensor	Organic-based wearable tracks blood-oxygen levels and measures pulse rate	Evolving
U-Wake	U-Wake sensor	headband uses EEG sensors to monitor brainwaves and analyze fatigue level	Evolving
VivaLnk	eSkin™ Thermometer	electronic circuitry with embedded sensors on a thin, flexible material that comfortably adhere to the skin to measure temperature	Evolving
WiseWear	Evolve™	Uses the Nomad core sensor platform in a chest strap, shirt clip, or wristband to track heart rate, respiration, motion, global movement, galvanic skin response, and blood oxygenation and transmitted to a mobile device.	Soon to be released
Chemical/Particulate			
Breathe	Breathe	Air quality sensors in a wearable clip to measure air pollution, report a user's air pollution readings to crowdsourced dataset, and alert a user of air pollution.	Evolving

Wepo	[Wepo air pollution monitor](#)	wearable pollution-exposure-monitoring device equipped with an electrochemical carbon monoxide sensor	Soon to be released
Other			
First Sign, MaceWear	[5-in-1 Pod automatic personal security system](#)	Attaches to common devices such as a keychain, belt clip, wristband, pendant or headband, and serves as an assault alert, fall alert, and panic button.	Available
Pauline van Dongen and TU Eindhoven & Textile Museum	[Vigour clothing for rehabilitation and physical therapy](#)	Clothing that tracks a user's movements and make the data available to a mobile app for use by the patient, therapist, caretakers, etc., with intended applications in rehabilitation and physical therapy	Evolving
ReTiSense	[Stridalyzer smart insoles](#)	uses insoles equipped with patent-pending technology of multiple sensors that communicate stride information to a smart device	Soon to be released
Torch	[Torch](#)	Uses infrared sensors worn on the head or chest that emit an audible or vibrating warning when the user approaches an obstacle.	Evolving
Triax SIM-P	[Triax SIM-P head band](#)	Triax SIM-P fits into a headband or cap and measures G-force of head impacts and sends alerts to smart devices.	Available
Displays			
Heads-Up			
Intel, Luxottica Group	[Smart sports eyewear](#)	Intel Corporation and Luxottica Group S.p.A announced a multiyear collaboration to create smart sports eyewear.	Evolving
Microsoft	[Virtual reality headset](#)	Microsoft is anticipated to unveil a virtual reality headset at the E3 conference in June 2015.	Evolving
Oculus	[Oculus](#)	Oculus announced three acquisitions/partnerships: Nimble VR, 13th Lab, and Chris Bregler, motion expert	
Osterhout Design Group	[Smart glass platform](#)	Smart-glass platform capable of running full Android tablet software and sharp optics on clear glasses	Soon to be released
Sony	[Single-Lens Display Module](#)	Attaches and beams display onto user's glasses	Evolving
Body-worn			
Google, Intel	[Google Glass v2](#)	Intel being integrated into the upcoming iteration of Google Glass	Evolving
Honeywell	[Wearable Solution for the Dolphin 70e Mobile Computer](#)	Hands-free, wrist-worn Dolphin 70e Black mobile device intended to support warehouse operations	Soon to be released

Power			
Chargers			
SolarHug	SolarHug bracelet	Transforms solar energy into power for a smartphone or other devices via USB.	Evolving
Self-Powering/Harvesting			
Lanzhou University, Chinese Academy of Sciences	Wearable triboelectric generator	Wearable triboelectric generators that harvest body motion energy	Evolving
Natick Soldier Research, Development, and Engineering Center	Soldier-worn power sources	Portable, energy-harvesting technologies to reduce the need for soldiers to carry extra batteries	Evolving
Texas Instruments	Wireless sensor technology	Electronics that turn small amounts of power generated by harvested sources (body movement) into useful power sources	Evolving
Power Supplies			
Fujitsu Laboratories Ltd.	Middleware	Sensing middleware that simplifies development of low-power sensing applications by essentially intercepting requests for notification from applications	Evolving
Communications			
Integrated voice/data/video			
Telepathy Inc.	Jumper	A neck-worn and eye-worn device with an optical display, camera, microphone, and sensors and an app that allow the user to share their field of vision and other information with others.	Soon to be released
Short-range low-power Bluetooth			
Alpha	NFC ring	Communicates with other NFC devices, allowing the user to unlock NFC-enabled doors, communicate with NFC-enabled phones, and transfer information.	Available
Caseco	Blu-Toque dual-layered Bluetooth hat	Hat equipped with Bluetooth technology that allows the user to take calls, listen to music, etc. wirelessly and without headphones.	Available
Hands-free Operations			
Fin	Fin thumb ring	Smart thumb ring that utilizes Bluetooth and allows the user to engage with smart devices and appliances to share information and communicate.	

Fullpower	MotionX Sensor-Fusion technology	Awarded a patent (8,902,154) for motion and gesture control in wearable devices, supplementing the company's MotionX Sensor-Fusion technology.	Available
Institute for Integrative Nanosciences, Institute for Solid State and Materials Research Dresden	Flexible magnetic field sensors	Flexible bismuth Hall sensors that can bend around the wrist or be positioned on the finger, with only a minor reduction in sensor performance, and create an interactive pointing device for wearable devices.	Evolving
Exoskeletons			
Argo	Kineseowear, Ouijaband, LaLaLa	These wearables provide cues for action, steady a user's grip, and help users focus on what they (don't) want to hear or see.	Evolving
Daewoo Shipbuilding and Marine Engineering	Robotic suit	An exoskeleton suits of light-weight aluminum alloy and steel, with straps at the feet, thigh, waist, and chest, and comprising hydraulic joints and electric motors connected to a backpack that powers the robotic suit	Evolving
Defense Advanced Research Projects Agency	Airlegs	Powered by a tank of compressed air, pulleys and electronic sensors connect to braces that essentially help pull the user's legs	Evolving
Wearable Computers			
UK Home Office	Police force technologies	The UK is consider wearables - body cameras, light-weight armor, graphene material, smart watches, digital glasses, and exoskeletons - to support police officers.	Evolving
Other			
Canatu	Nanobud	designed to conduct electricity while providing flexibility and durability fit for flexible and foldable devices	Available
DuPont Microcircuit Materials	Stretchable electronic ink materials	Durable, stretchable electronic ink materials that can be embedded into garments	Soon to be released
Elliott Fight Dynamics	StrikeTec sensor	Wrist-worn device that can track punch speed, force, type, count, and more to help an athlete analyze their punch performance	Evolving
Intel	Real-time facial recognition system	Intel patented a system for real-time facial detection using an image or video from a mobile device.	Evolving

Massachusetts Institute of Technology	Simultaneous Localization And Mapping (SLAM) systems	Incorporates different positioning technologies including GPS to track physical location, LIDAR to measure light pulses, Gyroscopes to adjust for tilt, accelerometers to measure speed, barometer to measure air pressure changes, and a camera to allow first responders to generate real-time maps.	Evolving
Massachusetts Institute of Technology, Stratasys	3D wearable skins	Integrate engineered cells made by Stratasys's 3D printing technology, the suits are designed to hold living matter while enabling a range of tasks.	Evolving
Norton, Betabrand	Radiofrequency identification blocking garments	clothing that blocks unwanted wireless communications by blocking RFID and NFC transmissions	Soon to be released
Performance Lab	ARDA Coaching Engine	Patented software platform fuses sports science, coaching, and technology, and incorporates data regarding geography, physiology, and history	Soon to be released
Pinto	Pinto storage wristband	Wrist-worn 32-64GB storage device that connects wirelessly via Bluetooth to devices, no internet required.	Evolving
Spansion, Sensoplex	Wearable development platform	An evaluation and development kit platform comprising microcontrollers with low-power management, flash memory, interface for wireless data communications, and more.	Evolving
Strap	Strap Metrics and Strap Kit	Raised $1 million seed investments to invest in product development. The company is the creator of Strap Metrics and Strap Kit analytics platforms designed for wearable applications.	
TUV Rheinland	Smart wearable device certification	The seminar welcomed manufacturers to discuss safety requirements, testing, quality, data accuracy and more, relative to the development of wearables	Available
University of Toronto Mississauga	Player Tracking System	Comprises a Moto360 watch worn by the player that communicates with an Onyx Beacon located on the field perimeter and ultimately uploaded to an IBM Bluemix server	Evolving
XOEye Technologies	http://www.xoeye.com/blog	Committed $1.5 million in Series A funding in the wearables field	
YESJ EXPERT, AYEIM	AYEFI	GPS-equipped wearable that alerts others of the user's location	Soon to be released

General			
CBInsights	Top 10 Wearable Tech Deals in 2014	This article summarizes the top 10 financing deals (totaling nearly $1 billion in funding) in wearables in 2014.	
Intel	Intel partnerships	Intel partnered with eyewear maker Luxottica Group to create smart eyewear; Google for the next generation of Google Glass; SMS Audio to create the BioSport headphones; and Opening Ceremony to create a smart bracelet.	
Intel, TAG Heuer	Smartwatch	Intel is reported to be partnering with Swiss watchmaker TAG Heuer in the area of smartwatches.	
Intelligence Advanced Research Projects Activity	Request for Information for wearables	The Intelligence Advanced Research Projects Activity issued a request for information for "Future Applications of Sensing Technologies for Fidelitous Wearable Devices.	Evolving
UK Home Office	UK Police Forces technology	The UK Home Office is exploring opportunities to outfit British police officers with protective wearables	
Wareable	Mergers and acquisitions of 2014	This article summarizes the top mergers and acquisitions of 2014 relative to wearables: Facebook and Oculus VR, Intel and Basis Science, Facebook and Moves, Google and Nest, Microsoft and Osterhout Design Group, and Covidien and Zephyr.	
Yahoo! Inc.	Yahoo Inc. wearables	Yahoo announced it will be growing in the wearable devices industry.	