Responder Technology Alert (May 2015)

June 2015

JF Upton
SL Stein
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PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

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Pacific Northwest National Laboratory
Richland, Washington 99352
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Appendix A Technology Summary ..................................................................A.1
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 Atlas Wearables

Technology name: Atlas Wristband activity tracker

Description: The Atlas Wristband uses machine learning and analytics to track more than 50 activities and relevant metrics (reps, calories, heart rate, etc.). The device allows users to log workouts, analyze data, and suggest new exercise routines. The device is waterproof to 50m and uses Bluetooth to share data with a smart device.

Status: Evolving – available for preorder

Funding: In-Q-Tel

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

Source: In-Q-Tel Strategically Invests in Atlas Wearables Technology
http://www.virtual-strategy.com/2015/05/18/q-tel-strategically-invests-atlas-wearables-technology#axzz3aoEd4YUF

2.1.2 California State University, iRythm

Technology name: iRythm ECG monitor

Description: Researchers are pursuing a wearable ECG monitor patch that is small (5cm), waterproof, and comprising a system-on-chip, sensor, microprocessor, and Bluetooth connectivity. The device is intended to be able to be worn for longer periods of time than typical ECG monitors.

Status: Evolving

Funding:

Product link:

Source: Skin-Like Wearable Device Monitors Heart Health
http://www.emdt.co.uk/daily-buzz/skin-wearable-device-monitors-heart-health

2.1.3 Cambridge Cognition

Technology name: Cognitive testing

Description: Cambridge Cognition filed a patent for technology to assess cognitive function and neurological conditions. Cambridge Cognition is exploring the use of physiological health data from wearables to trigger cognitive tests for users to establish a record of and better understand a user’s mental
function. Such information, Cambridge Cognition suggests, could shed light on conditions such as Alzheimer’s, depression, stress, anxiety, etc.

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** Wearable cognitive assessment devices a step closer as Cambridge Cognition file new patents

---

### 2.1.4 Chinese Academy of Sciences

**Technology name:** E-skin physiological sensor

**Description:** This research explores e-skin the uses flexible electronics and nanotechnology in a thin film of carbon nanotubes and graphite oxide that can be worn close to the skin. The sensors monitor and transmit a user’s blood pressure, pulse, etc., to provide real-time diagnostics.

**Status:** Evolving

**Funding:**

**Research link:**

**Source:** Card-sized diagnostics, e-skin are future of wearable medicine

---

2.1.5 Colorado University Boulder

**Technology name:** Skin temperature sensor

**Description:** Students are developing a wearable that measures skin temperature and allows a user to indicate their comfort, with a goal that the device could eventually recognize a user’s thermal state and automatically adjust the heating/cooling. For example, a user swipes left or right to indicate if it is too hot or too cold. The current prototype comprises a skin temperature sensing platform and the data acquisition module.

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** Wearable Skin Temperature Logger
http://www.instructables.com/id/Wearable-Skin-Temperature-Logger/

![Photo source: http://www.instructables.com/file/FW1IEJ99BKUXZ](http://www.instructables.com/file/FW1IEJ99BKUXZ)

2.1.6 Echo Labs

**Technology name:** Blood-monitoring wristband

**Description:** Echo Lab’s health-monitoring wristband uses optical signals to measure oxygen, CO2, pH, hydration, and blood pressure. Various industries have inquired about the device for its ability to monitor blood composition. The device shines electromagnetic waves into the skin and uses a proprietary algorithm to measure the reflection of the waves and measure molecules in the blood, given that different molecules will have different wave frequencies. Echo Labs suggests their algorithm can measure blood composition of a user that is in motion or at rest.

**Status:** Evolving

**Funding:**
Product link: https://angel.co/echo-labs

Source: This Wearable Prototype Can See Through Skin To Scan Your Blood

### 2.1.7 Ecole Polytechnique Federale de Lausanne (EPFL)

**Technology name:** Sweat nanosensor

**Description:** This sensor in an adhesive electronic stamp, with microscopic transistors, attaches to the skin to analyze sweat (ions, protons, pH, proteins, calcium, sodium, potassium, etc.) and measure hydration, stress, or fatigue.

**Status:** Evolving

**Funding:** Funded by the Swiss national program Nano-Tera within the project “NanowireSensor.”

**Research link:** http://pubs.acs.org/doi/abs/10.1021/nn5064216

Source: Soon, wearable device that assesses your health via sweat

### 2.1.8 Fujitsu: FEELythm

**Technology name:** Feelythm

**Description:** Designed for drivers, Feelythm comprises an ear-worn and neck-worn wearable pulse sensor and mountable receiver for inside the vehicle. The wearable uses a Fujitsu Laboratories algorithm to assess the user’s pulse and gauge drowsiness, sending an alert to the neck device, which vibrates and makes noise to alert the driver. The data is stored in the cloud and also transmitted to the driver’s command center. The device features a 5-day battery life. Fujitsu also developed a band that collects a user’s vitals (pulse rate, temperature, location, humidity) and uses algorithms to interpret the data to monitor stress, fatigue, and even falls or accidents. Developers propose the module could help users recognize signs of heat stroke, hypothermia, and other conditions.

**Status:** Evolving

**Funding:**

**Product link:** http://www.fujitsu.com/global/about/businesspolicy/business/ubiquitous/

Source: Fujitsu’s new wearables might not be sexy, but they could save your life
https://www.techinasia.com/fujitsu-enterprise-wearable-tech/
2.1.9 Fujitsu: Ubiquitous

**Technology name:** Ubiquitousware vital-sensing band

**Description:** Fujitsu developed a band that collects a user’s vital signs (pulse rate, temperature, location, humidity) and uses algorithms to interpret the data to monitor stress, fatigue, and even falls or accidents. Developers propose the module could help users recognize signs of heat stroke, hypothermia, and other conditions.

**Status:** Evolving – scheduled for debut in December

**Funding:**


**Source:** Fujitsu’s new wearables might not be sexy, but they could save your life [https://www.techinasia.com/fujitsu-enterprise-wearable-tech/](https://www.techinasia.com/fujitsu-enterprise-wearable-tech/)

2.1.10 MC10, University of Rochester: BioStamp

**Technology name:** BioStamp

**Description:** Researchers are collaborating to combine physiological sensing and pattern recognition algorithms with clinical expertise and big data analytics for possible healthcare applications. The goal is to identify how biometric data from physiological sensors can inform disease-specific algorithms and predictive health analytics. The work utilizes MC10’s BioStamp biometric sensing device, software, cloud storage, and computing platform. As one potential application, researchers propose the work can benefit monitoring the progression of neurological conditions and impact of subsequent therapies.

**Status:** Evolving

**Funding:**

**Product link:**
Source: Rochester Researchers to Test MC10’s Biostamp Wearable Biometric Sensing Sticker

2.1.11 McLaren Applied Technologies

Technology name: Wearable to reduce jet lag

Description: The proposed device would analyze vital signs over time then analyze that data to predict the best time for the user to travel.

Status: Evolving

Funding:

Product link:

Source: McLaren wearable gadget to end jet lag
http://www.itproportal.com/2015/05/15/mclaren-wearable-gadget-to-end-jet-lag/

2.1.12 Osram Opto Semiconductors: SFH 7051 BioMon Sensor

Technology name: SFH 7051 BioMon Sensor

Description: Osram Opto’s energy-efficiency, green LED optical sensors products measure heart rate by shining light on the skin and measuring the volume of blood passing through by amount the light absorbed by blood and the surrounding tissue. The device features energy-efficient green emitter chips that result in extended battery life. The device is the next in Osram Opto’s line of health-monitoring technologies.

Status: Available

Funding:


Source: Osram Opto Vying Wearable Device Market with New Green LEDs for Heart Rate Monitoring.

Photo source: 1 http://www.osram-os.com/
2.1.13 Pursuit Enterprises

Technology name: Sleep technology

Description: Targeted at pilots and train or truck operators, the device alerts users who become drowsy while driving or working. It may also have applications for users with sleep-related disorders. The device uses miniature sensors near the user’s eye and delivers alerts to an earbud-type device in the ear. The device also sends alerts to other users, such as a command center.

Status: Evolving

Funding:

Product link: http://pursuitenterprisesllc.com/

Source: Newly patented device intends to solve sleep deprivation crises using wearable sensor technology http://www.prweb.com/releases/2015/05/prweb12721526.htm

2.1.14 Snowcookie

Technology name: Snowcookie skin sensor

Description: Designed for skiers, Snowcookie monitors a user’s body position, fatigue, muscle reaction, and movement, then alerting the user to trends in performance and making recommendations for a break. The device can also detect falls and call for help. The device uses artificial intelligence to wirelessly aggregate the user’s data with others and make recommendations, such as for a specific trail matched to the user’s skill level.

Status: Evolving

Funding:

Product link: http://snowcookie.eu/

Source: Snowcookie is a wearable device which makes you a better, safer and connected skier http://icrowdnewswire.com/2015/05/24/snowcookie-is-a-wearable-device-which-makes-you-a-better-safer-and-connected-skier/

2.1.15 toSense: CovVa™ Monitoring System

Technology name: CoVa Monitoring System

Description: toSense is a remote heart-monitoring device designed to detect issues up to two weeks earlier than existing techniques. The device tracks a user’s heart rate, fluid buildup, respiration, stroke volume, cardiac output and other data and transmits the data to the cloud, where it will be available to doctors.

Status: Evolving
**Funding:** $3 million in funding from an investor

**Product link:** [http://www.tosense.com/](http://www.tosense.com/)


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### 2.1.16 University of British Columbia: Reveal

**Technology name:** Reveal

**Description:** Reveal’s embedded sensors measure indicators of anxiety, including sweat, heart rate, and skin temperature, and transmit the data to a smart phone, with a goal to identify meltdowns before they happen.

**Status:** Evolving

**Funding:**

**Product link:** [http://awakelabs.com/reveal/](http://awakelabs.com/reveal/)

**Source:** UBC students develop wearable device that monitors anxiety in autistic children [http://news.ubc.ca/2015/05/19/ubc-students-develop-wearable-device-that-monitors-anxiety-in-autistic-children/](http://news.ubc.ca/2015/05/19/ubc-students-develop-wearable-device-that-monitors-anxiety-in-autistic-children/)

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### 2.1.17 University of California San Diego

**Technology name:** Biomedical sensor

**Description:** Researchers are developing “a seamless, compact and non-intrusive, high-sampling-speed biomedical sensor for health monitoring.” The “smart skin” device comprises thin, multi-model electronic sheets with readout circuitry on flexible substrates that affix to the skin and record, process, and transmit electrophysiological data.
**Status**: Evolving, patent pending

**Funding:**

**Product link:**

**Source**: Monolithic Integration of Ultra-Scaled High Performance Pin-Size Wearable Electronics
[http://techtransfer.universityofcalifornia.edu/NCD/25044.html](http://techtransfer.universityofcalifornia.edu/NCD/25044.html)

### 2.1.18 University of Strathclyde

**Technology name**: Skin-worn hydration monitoring sensors

**Description**: The University of Strathclyde is developing a transdermal sensor to analyze electrolytes in sweat and provide real-time analysis of fluid loss during exercise. The device uses Bluetooth to send data to a smart device, which provides hydration information to the user, allowing them to analyze their performance. The device focuses on hydration as a key element of physical performance that, when lacking, can lead to fatigue, dizziness, and more.

**Status**: Evolving

**Funding:**

**Product link:**

**Source**: Performance-enhancing wearable hydration sensor provides immediate feedback

### 2.1.19 WellBe

**Technology name**: WellBe stress bracelet

**Description**: WellBe monitors a user's heart rate and uses a patent-pending algorithm to alert a user when they are getting stressed. Compared to other heart-rate monitors, WellBe ties heart rate to stress levels to help a user recognize and avoid stressful situations, and it is also made from cork to be lightweight and comfortable.

**Status**: Evolving

**Funding**: Crowdfunding – surpassed $100,000 target

**Product link**: [https://www.indiegogo.com/projects/the-wellbe#/story](https://www.indiegogo.com/projects/the-wellbe#/story)

**Source**: Finally! A wearable that tells you when someone is too annoying to be around
2.1.20  Yu: HealthYu

Technology name: HealthYu

Description: HealthYu fits on a smartphone and gathers and transmits health-related data (heart rate, respiration rate, blood pressure, body temperatures, ECG).

Status: Soon to be released

Funding:


![Image of HealthYu](http://www.yuplaygod.com/accessories/healthyu/)


2.2  Other

2.2.1  Aroma Technology: NEXTToMe

Technology name: NEXTToMe

Description: NEXTToMe features sensors that detect carbon monoxide, temperature, blood alcohol content, UV rays, humidity, air pressure, altitude, and more. The information is transmitted to the NEXTToME app and shared with other users. The device is intended to create a network of data to provide users insight into their environmental conditions. The device offers a month-long battery life, is lightweight (26g), and small (1.8x0.35in). It can be mounted to a variety of surfaces.

Status: Evolving

Funding: Crowdfunding

Product link: [http://www.aroma-technology.com/](http://www.aroma-technology.com/)

Source: NEXTToMe Wearable Device Detects Multiple Environmental Factors to Keep You Healthy

2.2.2 King Abdullah University of Science and Technology (KAUST)

Technology name: Nanoscale fin-shaped transistors

Description: Researchers are developing flexible, fin-shaped, metal-oxide-semiconductor transistors that can be placed on a variety of surfaces. The devices retain their electrical properties even when bending. The technology allows for implantable or embedded sensors, anticipated to be optimal for differently shaped devices and wearables in a range of materials and configurations.

Status: Evolving

Funding:

Product link:

Source: Wearable, implantable sensors possible with flexible transistors

2.2.3 REFLX: Boogio Bionic Foot Sensor

Technology name: Boogio Bionic Foot Sensor

Description: This thin “smart shoe” sensor is placed in a shoe and tracks a user’s movement, gravitation force, inner balance, and more, and analyzes the data to help better understand a user’s movement. The sensors can indicate the user’s foot pressure, balance, and movement.

Status: Evolving
Funding:

Product link: [https://boogie.com/](https://boogie.com/)


### 2.2.4 Sungkyunkwan University

**Technology name:** Facial expression sensor

**Description:** This sensor, comprising a carbon nanotube film on electrically conductive elastomers, analyzes human expressions (smiling, frowning, brow-raising, etc.) and eye movement of persons wearing the sensor. Researchers suggest the device detects small strains on human skin, which are often the result of emotion.

**Status:** Evolving

**Funding:** Supported by the Basic Science Research Program (2013R1A2A1A01015232) through the National Research Foundation (NRF), funded by the Ministry of Science, ICT, & Future Planning.

**Research link:** [http://pubs.acs.org/doi/abs/10.1021/acsnano.5b01613](http://pubs.acs.org/doi/abs/10.1021/acsnano.5b01613)

Source: Robots can read your face now, but via wearable device [http://www.microfinancemonitor.com/2015/05/01/sensors-robots-read-human-expressions-korean-researchers-interactive/](http://www.microfinancemonitor.com/2015/05/01/sensors-robots-read-human-expressions-korean-researchers-interactive/)

![Photo source: http://pubs.acs.org/doi/abs/10.1021/acsnano.5b01613](http://pubs.acs.org/doi/abs/10.1021/acsnano.5b01613)

### 2.2.5 X-labz

**Technology name:** UV badge

**Description:** The UV badge measures UV index, temperature, humidity, and air pressure every 2 seconds, collecting data over time to help users avoid sunburn, predict weather, and control or better understand their environment. The device comprises an ATtiny861A processor, LCD screen, sensors, and coin-cell battery with a month-long life.
**Status:** Available

**Funding:**

**Product link:** [https://hackaday.io/project/4706-uv-badge](https://hackaday.io/project/4706-uv-badge)

**Source:** Building a wearable UV index and weather sensor with tinyAVR

Meanwhile, the electronics are all neatly housed inside a 3D-printed case. A plexi cover was laser-cut and attached to a simple, white adhesive plastic mask. In his next iteration, the case will be shrunken down a bit, while the touch button will be replaced by a mechanical tactile button to conserve energy.
3.0 Displays

3.1 Heads-up (on face or head)

3.1.1 Allwinner

Technology name: Smart glasses

Description: Competitor of Google Glass, Allwinner’s smart glasses offer similar capabilities but for only $199. The device features Allwinner’s A33 system-on-chip, Bluetooth, wi-fi, and voice control, and pairs with a smartphone.

Status: Evolving

Funding:

Product link:

Source: Here Is The $199 Wearable That Will Compete With Google Glass
http://wccftech.com/199-wearable-compete-google-glass/

3.1.2 Fujitsu: Ubiquitousware

Technology name: Ubiquitousware head-mounted display

Description: Fujitsu’s new head-mounted display comprises a small display, camera, two microphones, and sensors. The camera can transmit the user’s field of vision to a remote user. The rugged device features a 4-hour battery life and can withstand a 1.5m fall. The user can operate the device with an arm-mounted keyboard and voice controls.

Status: Available

Funding:

Product link: http://www.fujitsu.com/global/about/businesspolicy/business/ubiquitous/

Source: Fujitsu’s new wearables might not be sexy, but they could save your life
https://www.techinasia.com/fujitsu-enterprise-wearable-tech/
3.1.3 Google

**Technology name:** Curved display

**Description:** Google’s recent patents suggest the next generation of Google Glass may feature a curved display that will help users perceive depth. The device would also be controlled using a touch interface. The display is suggested to have benefits for users determining the depth of field for whatever they are viewing.

**Status:** Evolving

**Funding:**

**Product link:** [Patent link](http://qz.com/398329/a-new-google-patent-hints-at-a-curved-display-for-the-next-generation-of-glass/)

**Source:** A new Google patent hints at a curved display for the next generation of Glass

Photo source: [https://www.techinasia.com/fujitsu-enterprise-wearable-tech/](https://www.techinasia.com/fujitsu-enterprise-wearable-tech/)
3.4 Trimble Partners, Microsoft

**Technology name:** Microsoft HoloLens and Trimble Connect, SketchUp, and V10 Imaging Rover

**Description:** Trimble Partners and Microsoft are integrating HoloLens head-mounted holographic display with Windows 10 with Trimble’s platforms to benefit architecture, engineering, and construction. The device will allow users to interact with 3D models and offers new opportunities for collaboration and sharing of information in a visual environment. In a recent demonstration at Microsoft’s Build Developer Conference, architects were able to interact with and manipulate their digital building sketches and share designs with remote collaborators. The partners’ work is using Trimble’s Connect (collaborative environment), SketchUp (3D modeling platform) and Imaging Rover (integrated camera system).

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** Trimble Partners with Microsoft to bring Microsoft HoloLens wearable holographic technology to the AEC industry


3.5 Vision Technologies

**Technology name:** Smart glasses

**Description:** Vision Technologies is developing software and created GiveVision.net to power smart glasses for visually impaired users. The software works on any wearable device.
Status: Evolving

Funding: Seeking investors

Product link: http://www.givevision.net/

Source: Funding to drive growth at wearable tech firm

3.2 Body worn (wrist, arm, or chest)

3.2.1 FlexEnable: Demonstrator

Technology name: Demonstrator flexible screen technology

Description: FlexEnable, specialized in flexible electronics, announced plans to create a Wearable Technology Lab. FlexEnable also recently demonstrated its transistor screen technology that offers an electroluminescent display fit for the sleeve of an outdoor jacket.

Status: Evolving

Funding:

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

Source: FlexEnable launches wearable technology lab
https://www.plusplasticelectronics.com/wearables/flexenable-launches-wearable-technology-lab

A FlexEnable wearable screen demonstrator has been designed for the outdoor apparel market –
Source: FlexEnable
3.2.2 Lenovo

Technology name: Magic View, Smart Cast, Smart Shoes

Description: Lenovo recently announced a range of wearables and displays including:

- The Magic View smartwatch offers two screens – a conventional and an interactive display—to simulate a screen “20 times the size of the main watch frame.” The approach is alleged to provide a better experience for map and video viewing.
- Smart Cast combines a laser projector and infrared motion detector in a smartphone. Developers expect it to allow for virtual keyboards and gesture-based interaction with projected displays.
- Smart Shoes, which uses Lenovo’s cloud-based internet-of-things ecosystem open software development kit in conjunction with footwear that tracks fitness data, provides GPS guidance, and reports on a user’s mood.

Status: Evolving

Funding:

Product link:

Source: Lenovo's Wearables Vision Includes a Dual-Screen Smartwatch
4.0 Power

4.1 Self-powering (Harvesters)

4.1.1 Chinese Academy of Sciences

Technology name: Perovskite solar cell

Description: Researchers are exploring ultra-thin, bendable perovskite solar cells with the ability to convert greater percentages of solar energy into electricity, and at a size “400 times thinner than conventional silicon cells.” Researchers are exploring applications such as weaving the cells into clothing, which could be ideal for chargers and wearable devices. According to researchers, in fiber the cells demonstrate a power conversion efficiency of 3% and maintain 89% efficiency after 96 hours in ambient conditions. They are working to address challenges such as the impact of air and moisture, which reduces productivity.

Status: Evolving

Funding:
- National Natural Science Foundation of China. Grant Numbers: 21273269, 11302241
- National Basic Research Program by Ministry of Science and Technology. Grant Number: 2010CB934700
- Knowledge Innovation Program by Chinese Academy of Sciences. Grant Number: KJCX2.YW.M12
- International Science and Technology Cooperation Project of Jiangsu Province. Grant Number: BZ2011049

Research link: http://doi.org/f272zw


4.1.2 Commonwealth Scientific and Industrial Research Organization: Flexible Integrated Energy Device

Technology name: Flexible Integrated Energy Device (FIED)

Description: The FIED is designed to be a wireless, wearable power source. The system features an energy-harvesting system that harnesses via the pack’s straps energy from the user’s body movements; a flexible battery; and washable fabric with conductive fibers that also connect to electronic devices. The FIED offers several outlets and pockets into which users can plug in their electronics, LED lights, and retractable USB cables.

Status: Evolving

Funding:

**Source:** Backpack Is a Wireless, Wearable Charging System

The Flexible Integrated Energy Device (FIED) is a backpack that combines wearable technology and wireless power sources to create a complete power system for your personal electronics. (Source: Commonwealth Scientific and Industrial Research Organization)

5.0 Communications

5.1 Hands-free operation

5.1.1 Aria Wearable

Technology name: Aria Wearable gesture controller

Description: The clip-on gesture controller clips to a smartwatch and allows a user to navigate the device using gestures. Gestures can be customized using the Aria app. The device has a built-in battery and uses Bluetooth Low Energy. Aria offers two versions, one for Pebble Time and one for Android Wear. It can also be used to control an iPhone or iPad, but not Apple Watch at this time. Users can use typical smartphone-type movements such as miming of tapping, swiping, etc. to control the device.

Status: Evolving

Funding: Crowdfunding

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


5.1.2 Google: ATAP Project Soli

Technology name: ATAP Project Soli

Description: ATAP Project Soli will allow users to interact with smaller screens and control smaller devices using gestures and “hand motion vocabulary.” The device uses radar to bring accuracy and precision to detecting fine hand and finger movements, allowing users to manipulate devices even through materials. The device features haptic feedback and is fit for small devices.

Status: Evolving – targeted for availability later this year.

Funding:

Product link:

5.1.3 Playtabase: Reemo

**Technology name:** Reemo gesture controller

**Description:** Reemo is a wrist-worn gesture controller that allows users to control home devices through pointing and six selected gestures. Users must be within 10 meters of a smart device. The device features a 48-hour battery life and is water resistant for up to 30 minutes and 3 meters deep.

**Status:** Soon to be released – expected October 2015

**Funding:** Playtabase recently gained an additional $100,000 in funding, plus an existing $400,000 from angels/partners and a previous accelerator.

**Product link:** [http://www.getreemo.com/](http://www.getreemo.com/)

**Source:** Minneapolis Wearable Startup Playtabase Lands Spot In Nashville Accelerator [http://tech.mn/news/2015/05/14/playtabase-reemo-nashville-accelerator-jumpstart-foundry/](http://tech.mn/news/2015/05/14/playtabase-reemo-nashville-accelerator-jumpstart-foundry/)
6.0 Cameras

6.1 GoPro

**Technology name:** Virtual reality device, quadcopter drone

**Description:** GoPro is developing a virtual reality device that uses six GoPro Hero cameras to create a spherical shot. The footage will be synced to the cloud, eliminating the need for memory cards. GoPro is also developing quadcopter drone that will take aerial footage.

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** GoPro News: Wearable Camera Company Working on a Virtual Reality Device and Drone

6.1.2 Inobrand: iSECAM-HD

**Technology name:** iSECAM-HD wearable security camera

**Description:** iSECAMHD is a clip-on wearable camera that offers 8 hours of recording with its rechargeable battery, 32GB memory, 4G/3G/wifi/GPS connectivity, 1921x180 HD resolution, encryption, night vision, and a weatherproof structure (water proof, impact resistant, withstands -3C-55C). It is small (120mm x 80mm x 40 mm) and weighs 168 grams.

**Status:** Available

**Funding:**

**Product link:** http://www.inobrands.com/wearable-security-body-camera

**Source:** Inobrands Wearable Security Camera – iSECAM-HD
http://www.inobrands.com/wearable-security-body-camera
6.1.3 Mobius

**Technology name:** Mobius wearable camera package

**Description:** The wearable camera package features the standard Mobius Camera with a proprietary magnet mount and clip to mount it on a visor, dashboard, or even a bow, as well as almost any surface. The small camera (1.38 x 2.40 x .72 inches) provides 1080P HD video and audio and its 820mah battery offers 120 minutes of recording time.

**Status:** Available

**Funding:**


**Source:** New Wearable Camera Package for the Standard Mobius
6.1.4 Sony: FDR-X1000V 4K Action Cam

Technology name: FDR-X1000V 4K Action Cam

Description: Sony’s Action Cam allows a user to monitor the device (up to 5 cameras) live via wifi on a wrist-mounted remote. The device features HD and 4k resolution, has a built-in stabilizer, and is waterproof to 3 meters. It offers a slender shape, fit for mounting aside helmets or other objects. It also has a dog mount, which may be of benefit to law enforcement.

Status: Available

Funding:

Product link: http://www.sony.net/Products/actioncam/en-us/products/cameras/FDR-X1000V/

Source: Sony's Action Cam takes on GoPro
http://www.afr.com/technology/review-sonys-action-cam-takes-on-gopro-20150511-ggwc
7.0 Exoskeletons

7.1.1 Alex Czech (individual)

Technology name: 3D-printed hand exoskeleton

Description: Developer Alex Czech is creating a 3D-printed hand exoskeleton, with a goal to advance to a full-body exoskeleton. The hand feature 13 printed parts, weighing 173 grams. The device costs an estimated $8.16 to create, including plastic, nuts, and bolts. Future versions could include elongated fingers for delicate handling of harmful materials.

Status: Available

Funding:

Product link: https://sellfy.com/p/BXw2/


7.1.2 Berkeley: Berkeley Lower Extremity Exoskeleton (BLEEX)

Technology name: Berkeley Lower Extremity Exoskeleton (BLEEX)

Description: Created to assist first responders, BLEEX was designed to be a “self-powered exoskeleton for strength and endurance enhancement of humans that is ergonomic, highly maneuverable, mechanically robust, lightweight and durable.” The exoskeleton allows for versatile transport and reduces load to the user. The prototype featured powered anthropomorphic legs, a power unit, and a backpack-style frame for mounting loads. It allows for mobility in all directions while carrying a load. Should the device lose power, the legs can be removed and the entire device becomes a standard backpack. The device utilizes a control algorithm that “ensures that the exoskeleton moves in concert with the pilot with minimal interaction force between the two. The control scheme needs no direct measurements from the human or from the human-machine interface (e.g., sensors between them). The controller,
based on measurements from the exoskeleton only, estimates (i.e., computes very quickly) how to move so that the wearer feels very few forces.”

**Status:** Evolving

**Funding:** Defense Advanced Research Project Agency (DARPA)


**Source:** BLEEX  
[http://bleex.me.berkeley.edu/research/exoskeleton/bleex/](http://bleex.me.berkeley.edu/research/exoskeleton/bleex/)

### 7.1.3 Buckhead Shepherd Center: Indego

**Technology name:** Indego

**Description:** Indego is a powered, lightweight (26 pounds) exoskeleton that mimics the movement of human legs, providing power at the hip and knees, essentially walking for the user.

**Status:** Evolving—Available for research purposes in clinical settings; commercial availability expected in 2015.
Funding:


Source: Buckhead’s Shepherd Center Helps Paralyzed Teen Walk for Graduation

### 7.1.4 Cyberdyne Inc.: Hyber Assistive Limb (HAL)®

**Technology name**: HAL

**Description**: Sumitomo Mitsui Banking Corp. is using Cyberdyne Inc. robotic suits to assist in cash delivery by reducing the load workers carry. The technology can reduce the burden by 40%. According to the Cyberdyne web site, “HAL® preforms assistance for the wearer’s motions by a combination of Cybernic Voluntary Control [CVC] system, with which Robot Suit® moves as the wearer intends by detecting [bio-electric signals], and Cybernic Autonomous Control [CAC] system, with which Robot Suit® replicates human motions based on fundamental motion patterns in the absence of BES.”

**Status**: Evolving – available in some countries

**Funding**: 


Source: Robot Suits To Help Bank Employees Deliver Heavy Cash Stacks

![Photo source: Sumitomo Mitsui Banking Corp.](image)

### 7.1.5 Esko Bionics: Industrial Exoskeleton

**Technology name**: Industrial Exoskeleton
Description: Esko Works Industrial Exoskeleton is a lightweight (16 lbs) and powerless, using counterweights and a standard, sprung arm like those used on image-stabilizing Steadicams. The device’s carbon fiber harness and metal-tube frame running down a user’s legs and translates the weight of the user’s load through the suit and into the ground.

Status: Evolving

Funding:


7.1.6 Jiazhen ‘Ken’ Chen (individual): Advanced Firefighting Apparatus

Technology name: Advanced Firefighting Apparatus

Description: Industrial designer Jiazhen ‘Ken’ Chen is developing the Advanced Firefighting Apparatus powered exoskeleton to increase firefighter’s performance (walking, running, carrying). The suit reduces the load of a firefighter, being able to load 91kg. It is customizable, can operate for two hours, and will be equipped with an impulse water gun system and movable joystick for operation.

Status: Evolving

Funding:

Product link: [https://www.behance.net/gallery/12324165/AFA-Powered-Exoskeleton-Suit-for-Firefighter](https://www.behance.net/gallery/12324165/AFA-Powered-Exoskeleton-Suit-for-Firefighter)

7.1.7 NYU Polytechnic School of Engineering

Technology name: Exoskeleton research

Description: Doctoral student Henry Clever is pursuing mathematical models of energetic performance and stability control for use in the design of lower-extremity robotic exoskeletons to accelerate the development of better-performing, lower-cost assistive devices. The exoskeleton aims to help users with lower limb impairments.

Status: Evolving

Funding: National Science Foundation


Source: NYU Engineering Student Earns Prestigious NSF Fellowship for Wearable-Robot Research
http://www.virtualpressoffice.com/publicsiteContentFileAccess?fileContentId=2015341&fromOtherPageToDisableHistory=Y&menuName=News&sId=&sInfo=

7.1.8 Revision Military

Technology name: Kinetic Operations Suit
**Description:** At the 2015 Special Operations Forces Industry Conference, Revision Military demonstrated its Kinetic Operations Suit, which offers a hard body-armor protection that covers 60% of the wearer and can stop rifling rounds. It is also load-bearing, reducing the weight to the users, and offers motorized actuators on each leg.

**Status:** Evolving – prototype expected in August 2018

**Funding:** SOCOM intends to funnel $80 million into research and development over the first four years.

**Product link:**

**Source:** Firms Pitch Exoskeletons and Body Armor for SOCOM’s Iron Man Suit  

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### 7.1.9 Samsung Elect Ltd

**Technology name:** Exoskeleton

**Description:** Samsung Elect Ltd plans to pursue exoskeletons to enhance the speed and strength of soldiers. Recent patents published related to a robot that attaches to the body and can be controlled by the wearer. The device detects the user’s movement and generates auxiliary torque to provide extra strength. According to patent illustrations, the device will feature electromyorgan sensors on each leg to communicate with the controller and move the device (and the wearer) forward. The device features a gyrometer and accelerometer that also registers the wearer’s movement and guides the exoskeleton.

**Status:** Evolving

**Funding:**

**Product link:** Patent information

**Source:** Samsung Brings “Call Of Duty” Exo Skeleton To Life  
7.1.10 United Instrument Manufacturing Corporation

Technology name: Mind-controlled dual-use exoskeleton

Description: Russia’s United Instrument Manufacturing Corporation is developing military-grade automated control and dual-use robotic systems for defense R&D tasks. The exoskeleton will help soldiers carry loads up to 300 kg. The system’s neuro interface will allow the user to control the suit through images; thinking of certain images will coordinate a response in the system.

Status: Evolving

Funding:

Product link:

Source: Will Russia Field Robo-Soldiers in 5 Years?
http://thediplomat.com/2015/05/will-russia-field-robo-soldiers-in-5-years/

7.1.11 University of Texas, Dallas

Technology name: Artificial muscles

Description: Researchers are exploring the use of high-strength polymer fishing line and sewing threat to create artificial muscles for exoskeletons, under the principle that “Coiled polymer fiber react to changes in temperature, contracting when heated and then loosening when cooled” similar to human muscles. These materials, in addition to being lightweight and affordable, contract even further than human muscles (30% more), giving added strength.

Status: Evolving
Funding:


### 7.1.12 Wyss Institute

**Technology name:** Soft exosuit

**Description:** Wyss’s is developing an exosuit that uses specially designed fabrics, which are lighter weight and allow for greater movement. Potential applications include reducing the physical burden of firefighters, paramedics, and other load-bearing occupations.

**Status:** Evolving

**Funding:**

**Product link:**

Source: Soft Exosuit [http://wyss.harvard.edu/viewpage/456](http://wyss.harvard.edu/viewpage/456)

![Wyss Institute Soft Exosuit Diagram](http://wyss.harvard.edu/viewpage/456)

The soft exosuit uses a combination of sensors, including a hyperelastic strain sensor (1) and sensors around the wearer’s hip, calf and ankle (2)-(5), all secured by straps. Flexible membranes cover sensors and straps (6).

Photo source: [http://wyss.harvard.edu/viewpage/456](http://wyss.harvard.edu/viewpage/456)
8.0 Wearable Computers

8.1.1 TypeTime: iType

**Technology name:** iType smartwatch

**Description:** The iType smartwatch is a wrist-worn smartphone with an improved typing feature. It features two navigation buttons on the watch’s side (a back button and a sleep/wake button), a camera, and a SIM card. The device is SIM-unlocked. The device is water resistant and has a battery life comparable to typical smartphones. It features a 240x240 display, MediaTek dual-core A7 CPU, 1GB of RAM, 8GB of storage, 5-megapixel camera with 720p video. It also offers wifi, Bluetooth, GPS, and G-Sensor connectivity (but not LTE).

**Status:** Available

**Funding:** Crowdfunding

**Product link:** [http://www.typetime.net/](http://www.typetime.net/)

**Source:** The iType smartwatch from TypeTime brings practical ability to type in feature packed wearable running full Android [http://www.phonearena.com/news/The-iType-smartwatch-from-TypeTime-brings-practical-ability-to-type-in-feature-packed-wearable-running-full-Android_id69303](http://www.phonearena.com/news/The-iType-smartwatch-from-TypeTime-brings-practical-ability-to-type-in-feature-packed-wearable-running-full-Android_id69303)
9.0 Other

9.1.1 Bridgecrest Medical

Technology name: Fatigue management

Description: Bridgecrest Medical’s design uses predictive analytics to measure fatigue and provide real-time medical alerts. A patient is screened for major risk factors impacting sleep; the results are synchronized with Bridgecrest Medical’s secure data analytics platform. The patient wears a smart watch that measures various biometrics (heart rate, quality/quantity of sleep), which is transmitted to a computer that then categorizes and analyzes the data into risk categories. The information is made available to the patient’s medical or safety team who can then make determinations about treatment or response, and it can also be compared to other users.

Status: Evolving

Funding:

Product link: http://www.bridgecrestmed.com/fatigue-management/


9.1.2 Digital FOV: Digital Crosshairs I-Targeting Monocular

Technology name: Digital Crosshairs I-Targeting Monocular wireless targeting monocular

Description: The Digital Crosshairs monocular is a wireless targeting accessory for the Digital Crosshairs rifle scope night vision clip that “transmits live video of the scope’s targeting field of view to a small wearable micro monitor that attaches to shooting glasses.” The device gives the user visibility of their surroundings with one eye, while the other can still see the crosshairs. The device automatically switches to infrared vision at night.

Status: Soon to be released – anticipated June 2015

Funding:

Product link: www.digitalcrosshairs.net


9.1.3 Fujitsu: Ubiquitousware

Technology name: Ubiquitousware location badge
Description: The Ubiquitousware badge offers pedestrian-dead-reckoning technology using an accelerometer and standard GPS. The location data can detect a user in a building and even one who has fallen down, as was demonstrated at a recent press conference using a mannequin. The technology can detect when a user is on an unstable surface or moving too fast and provide real-time monitoring.

Status: Available

Funding:

Product link: http://www.fujitsu.com/global/about/businesspolicy/business/ubiquitous/

Source: Fujitsu’s new wearables might not be sexy, but they could save your life https://www.techinasia.com/fujitsu-enterprise-wearable-tech/

9.1.4 Google: Project Jacquard

Technology name: Project Jacquard

Description: Project Jacquard is weaving technology into clothing, integrating touch and gesture interactivity into any textile using industrial looms, turning a garment into a touchpad. The technology is a platform essentially turning any cloth into an interactive surface. The touch panel will reside in just a portion of the garment and requires a chip and battery which are the size of button and sewn onto the garment. The technology features Bluetooth and wifi connectivity and utilizes sealed electronics allowing for machine washing.

Status: Evolving

Funding:

Product link: https://www.google.com/atap/project-jacquard/
Source: Project Jacquard: Google reinvents the wearable as stuff you actually wear
http://mashable.com/2015/05/30/project-jacquard-analysis-google/

9.1.5 Kinetic

Technology name: Smartbelt and alert system

Description: Kinetic’s two-part device detects when a user is lifting and which muscles are being used, indicating to users when they may be at risk for injury. The device features a wristband and back-brace with interacting sensors that calculate the risk of injury and use LED lights and/or vibration to warn a user.

Status: Evolving

Funding:

Product link: http://wearkinetic.com/

Source: Corporate Wellness: How a Wearable Belt, Smartband May Save Your Employees’ Backs
9.1.6 Massachusetts Technology Institute (MIT)

**Technology name:** Personal-cooling technology

**Description:** Researchers are developing personal-cooling technology “using an infrared-transparent visible-opaque fabric (ITVOF), which provides passive cooling via the transmission of thermal radiation emitted by the human body directly to the environment.” According to researchers, “By providing personal cooling in a form amenable to everyday use, ITVOF-based clothing offers a simple, low-cost solution to reduce energy consumption in HVAC systems.”

**Status:** Evolving

**Funding:**

**Research link:** [http://pubs.acs.org/doi/pdf/10.1021/acsphotonics.5b00140](http://pubs.acs.org/doi/pdf/10.1021/acsphotonics.5b00140)

**Source:** Infrared-Transparent Visible-Opaque Fabrics for Wearable Personal Thermal Management [http://pubs.acs.org/doi/pdf/10.1021/acsphotonics.5b00140](http://pubs.acs.org/doi/pdf/10.1021/acsphotonics.5b00140)

9.1.7 Mentor®: Embedded Nucleus®

**Technology name:** Embedded Nucleus® real-time operating system

**Description:** Embedded Nucleus® is a comprehensive operating system and protocol support for Internet-of-Things devices and cloud connectivity, equipped with built-in power management support, memory space partitioning, and system-on-chip architecture. The technology offers wi-fi, Bluetooth, and 6LoWPAN connectivity and extended battery life through effective power management. The device’s Qt® framework optimizes graphics capabilities while maintaining a small footprint fit for wearables.

**Status:** Available

**Funding:**


### 9.1.8 North Carolina State Textile Protection and Comfort Center

**Technology name:** First responder garments

**Description:** Researchers are developing clothing for emergency workers, with added protection against a range of hazards including fire, water, chemicals, jagged debris, etc. The team at North Carolina State Textile Protection and Comfort Center is partnered with Protect the Force Inc. to manufacture 150 of the prototypes for field testing with first responders.

**Status:** Evolving

**Funding:** $718,000 grant from the Department of Homeland Security

**Product link:**

Source: Outfitting First Responders [https://news.ncsu.edu/2015/05/outfitting-first-responders/](https://news.ncsu.edu/2015/05/outfitting-first-responders/)

### 9.1.9 QuickLogic Corporation: SenseMe™

**Technology name:** SenseMe algorithm library

**Description:** The SenseMe is comprehensive sensor fusion algorithm library, including fusion, activity, transport, gesture, and device location algorithms. The algorithms are acclaimed to shorten developer time, ensure cross-platform portability, reduce memory footprint, minimize power consumption, and support data from a range of sensor classes (i.e., inertial, magnetic, biological, proximity and light). The algorithms work with Android Operating System including KitKat 4.4, Lollipop 5.0 and real-time operating systems.

**Status:** Available

**Funding:**

**Product link:** [www.quicklogic.com/senseme](http://www.quicklogic.com/senseme)


### 9.1.10 ReVault

**Technology name:** ReVault wearable cloud
**Description:** ReVault is a portable, wearable hard drive that syncs a user’s data from multiple devices. The device uses wi-fi and Bluetooth and comes in 32GB and 128GB capacity.

**Status:** Evolving

**Funding:** Crowdfunding

**Product link:** [http://revault.io/](http://revault.io/)

**Source:** ReVault Happens To Be A Wearable Cloud

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### 9.1.11 Samsung: Artik

**Technology name:** Artik system-on-chip

**Description:** Samsung is developing a system-on-chip series “as powerful as full-fledge computers” to power smart devices and appliances. Artik 1 will offer Wi-Fi, BLE, Zigbee, RFID and Bluetooth connectivity, memory, and a 9-axis sensor path in a 11.5 mm x 12.5 mm chip. The Artik 6 SoC will be a computer on a chip, reportedly the size of an SD card, 1.8 MHz processor, 16GB RAM, and typical range of sensors and radiofrequency function.

**Status:** Available

**Funding:**

**Product link:** [https://www.artik.io/](https://www.artik.io/)

**Source:** Samsung Set To Unveil New Chips To Power Internet Of Things

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### 9.1.12 University of Exeter

**Technology name:** Electronic textiles with embedded, flexible graphene electrodes

**Description:** Researchers are exploring techniques to embed transparent, flexible graphene electrodes into fibers, creating electronic textiles. Proposed applications include clothing containing computers, phones, and MP3 players, as well as in textile GPS systems, biomedical monitoring, and personal security. The researchers are using monolayer graphene with exceptional electrical, mechanical, and optical properties.

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** Graphene holds key to unlocking creation of wearable electronic devices
9.1.13 University of Manchester

**Technology name:** Printable graphene for wearables

**Description:** Researchers are developing a binder-free process for printing graphene ink with high electrical conductivity and have successfully used the material to print a flexible radiofrequency antenna. The typical binding process requires additional heating not often fit for substrates for wearables. Using this bind-free process, the ink can dry at 100°C and be compressed, which reportedly “improved the adhesion of the graphene to the substrate, and it increased the conductivity of the applied graphene 50-fold.” Researchers proposed suggested applications such as RFID tags for wearable electronics.

**Status:** Evolving

**Funding:**

**Research link:** [http://dx.doi.org/10.1063/1.4919935](http://dx.doi.org/10.1063/1.4919935)

**Source:** Toward Printable Graphene for Wearable Electronics [http://www.osa-opn.org/home/newsroom/2015/may/toward_printable_graphene_for_wearable_electronics/](http://www.osa-opn.org/home/newsroom/2015/may/toward_printable_graphene_for_wearable_electronics/)

9.1.14 Utility Associates: Evidence EcoSystem

**Technology name:** Evidence EcoSystem evidence-capturing device

**Description:** The Evidence Ecosystem is a comprehensive evidence-capturing device connecting Internet-of-Things devices with real-time connectivity, data analysis, and data storage. The device features audio and video, Generation 2 BodyWorn video cameras, core-in-car video recording, fixed location video cameras, gunshot audio analysis and location reporting systems, automated license plate reader, 911 and computer-aided dispatch, video integration centers gathering multiple feeds, connectivity to the National Crime Center and other federal/state databases, crime zone prediction algorithms, and metadata evidence storage and distribution systems with the ability to share with involved parties. According to developers, “This integration provides reliable capture of the facts and can all be pulled together in AVaiL Web, which enhances officer safety and protecting citizen privacy rights.” AVaiL Web is described as a “secure command and control application that provides an automatic real-time, map-based view of the location and status of mobile operations, including personnel, vehicles and tools.” The device also integrates with DataSync, which updates every 15 seconds with a fleet’s location, diagnostics and RFID tag data.

**Status:** Available

**Funding:**

**Product link:**

**Source:** The Mobile IoT Engine is the Future [http://www.utility.com/products/](http://www.utility.com/products/)
9.1.15  Wild Acre Metals, Nuheara

**Technology name**: Hearing and speech technology

**Description**: Wild Acre Metals is entering the wearables market after acquiring Nuheara, which created wireless earbuds that allow users to augment their hearing and connect (cable free) to voice-enabled smart devices. The partners will create “hearing technology platform that combines unique speech augmentation software with spatial directionality and placement, Bluetooth connectivity and app software components.”

**Status**: Evolving

**Funding**:

**Product link**: [http://nuheara.com/](http://nuheara.com/)

9.1.16 WISEKey SA: NFCTrusted©

**Technology name:** NFCTrusted

**Description:** WISEKey is developing trusted near-field communications (NFC) technology, integrating security authentication and identification with wearable devices. According to the press release, “NFCTrusted© authentication tags can incorporate a WISEKey cryptographically secure digital certificate to prove authenticity. NFCTrusted© tags can be embedded in virtually any product, piece of equipment or common household item, and users can verify authenticity with an NFC-enabled smart phone, watch, connected device or other mobile device.”

**Status:** Evolving

**Funding:**

**Product link:**

**Source:** WISEKey Deploying large Scale IoT Digital Identities for Wearables with WISEID NFCTrusted(c) Technology

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.

<table>
<thead>
<tr>
<th>Company</th>
<th>Technology</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlas Wearables</td>
<td>Atlas Wristband activity tracker</td>
<td>Uses machine learning and analytics to track more than 50 activities and relevant metrics and allows users to log workouts, analyze data, and suggest new routines.</td>
<td>Evolving</td>
</tr>
<tr>
<td>California State University</td>
<td>iRhythm ECG monitor</td>
<td>Wearable ECG monitor patch that is small (5cm), waterproof, and comprising a system-on-chip, sensor, microprocessor, and Bluetooth connectivity.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Cambridge Cognition</td>
<td>Cognitive testing</td>
<td>Uses physiological health data from wearables to trigger cognitive tests for users to establish a record of and better understand a user’s mental function.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Chinese Academy of Sciences</td>
<td>E-skin physiological sensor</td>
<td>Flexible electronics and nanotechnology in a thin film of carbon nanotubes and graphite oxide that can be worn close to the skin. The sensors monitor and transmit a user’s blood pressure, pulse, etc., to provide real-time diagnostics.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Colorado University Boulder</td>
<td>Skin temperature sensor</td>
<td>Measures skin temperature and allows a user to indicate their comfort, with a goal that the device could eventually recognize a user’s thermal state and adjust the heating/cooling.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Echo Labs</td>
<td>Blood-monitoring wristband</td>
<td>Health-monitoring wristband uses optical signals to measure oxygen, CO2, pH, hydration, blood pressure.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Ecole Polytechnique Federale de Lausanne</td>
<td>Sweat nanosensor</td>
<td>This sensor in an adhesive electronic stamp, with microscopic transistors, attaches to the skin to analyze sweat (ions, protons, pH, proteins, calcium, sodium, potassium, etc.) and measure hydration, stress, or fatigue.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>Feelythm</td>
<td>Feelythm comprises an ear-worn and neck-worn wearable pulse sensor and mountable receiver for inside the vehicle.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>Ubiquitousware vital-sensing band</td>
<td>Collects a user’s vital signs (pulse rate, temperature, location, humidity) and uses algorithms to interpret the data to monitor stress, fatigue, and even falls or accidents.</td>
<td>Evolving</td>
</tr>
<tr>
<td>MC10, University of Rochester</td>
<td>BioStamp</td>
<td>Utilizing MC10’s BioStamp biometric sensing device, software, cloud storage, and computing platform to combine physiological sensing and pattern recognition algorithms with clinical expertise and big data analytics for possible healthcare applications</td>
<td>Evolving</td>
</tr>
<tr>
<td>McLaren Applied Technologies</td>
<td>Wearable to reduce jet lag</td>
<td>The proposed device would analyze vital signs over time then analyze that data to predict the best time for the user to travel.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Osram Opto Semiconductors</td>
<td>SFH 7051 BioMon Sensor</td>
<td>Energy-efficiency, green LED optical sensors products measure heart rate by shining light on the skin and measuring the volume of blood passing through by amount the light absorbed by blood and the surrounding tissue</td>
<td>Available</td>
</tr>
<tr>
<td>Pursuit Enterprises</td>
<td>Sleep technology</td>
<td>Uses miniature sensors near the user’s eye and delivers alerts to an earbud-type device in the ear. The device also sends alerts to other users, such as a command center.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Snowcookie</td>
<td>Snowcookie skin sensor</td>
<td>Monitors a user’s body position, fatigue, muscle reaction, and movement, then alerting the user to trends in performance and making recommendations for a break.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Company/Institution</td>
<td>Technology/Device Name</td>
<td>Description</td>
<td>Development Stage</td>
</tr>
<tr>
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</tr>
<tr>
<td>toSense</td>
<td>CovVa™ Monitoring System</td>
<td>Remote heart-monitoring device that tracks a user’s heart rate, fluid buildup, respiration, stroke volume, cardiac output and other data and transmits the data to the cloud, where it will be available to doctors.</td>
<td>Evolving</td>
</tr>
<tr>
<td>University of British Columbia</td>
<td>Reveal</td>
<td>Embedded sensors that measure indicators of anxiety including sweat, heart rate, and skin temperature, and transmit the data to a smart phone, with a goal to identify meltdowns before they happen.</td>
<td>Evolving</td>
</tr>
<tr>
<td>University of California San Diego</td>
<td>Biomedical sensor</td>
<td>Thin, multi-model electronic sheets with readout circuitry on flexible substrates that affix to the skin and record, process, and transmit electrophysiological data.</td>
<td>Evolving</td>
</tr>
<tr>
<td>University of Strathclyde</td>
<td>Skin-worn hydration monitoring sensors</td>
<td>Transdermal sensor to analyze electrolytes in sweat and provide real-time analysis of fluid loss during exercise.</td>
<td>Evolving</td>
</tr>
<tr>
<td>WellBe</td>
<td>WellBe stress bracelet</td>
<td>Monitors a user’s heart rate and uses a patent-pending algorithm to alert a user when they are getting stressed.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Yu</td>
<td>HealthYu</td>
<td>Fits on a smartphone and gathers and transmits health-related data (heart rate, respiration rate, blood pressure, body temperatures, ECG).</td>
<td>Soon to be released</td>
</tr>
</tbody>
</table>

**Other**

<table>
<thead>
<tr>
<th>Company/Institution</th>
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<th>Description</th>
<th>Development Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aroma Technology</td>
<td>NEXTToMe</td>
<td>Features sensors that detect carbon monoxide, temperature, blood alcohol content, UV rays, humidity, air pressure, altitude, and more.</td>
<td>Evolving</td>
</tr>
<tr>
<td>King Abdullah University of Science and Technology</td>
<td>Nanoscale fin-shaped transistors</td>
<td>Flexible, fin-shaped, metal-oxide-semiconductor transistors that can be placed on a variety of surfaces. The devices retain their electrical properties even when bending.</td>
<td>Evolving</td>
</tr>
<tr>
<td>REFLX</td>
<td>Boogio Bionic Foot Sensor</td>
<td>“Smart shoe” sensor placed in a shoe and tracks a user’s movement, gravitation force, inner balance, and more, and analyzes the data to help better understand a user’s movement.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Sungkyunkwan University</td>
<td>Facial expression sensor</td>
<td>Sensor, comprising a carbon nanotube film on electrically conductive elastomers, analyzes human expressions (smiling, frowning, brow-raising, etc.) and eye movement of persons wearing the sensor.</td>
<td>Evolving</td>
</tr>
<tr>
<td>X-labz</td>
<td>UV badge</td>
<td>Measures UV index, temperature, humidity, and air pressure every 2 seconds, collecting data over time to help users avoid sunburn, predict weather, and control or better understand their environment.</td>
<td>Available</td>
</tr>
</tbody>
</table>

**Displays**

**Heads-Up Display**

<table>
<thead>
<tr>
<th>Company/Institution</th>
<th>Technology/Device Name</th>
<th>Description</th>
<th>Development Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allwinner</td>
<td>Smart glasses</td>
<td>Affordable smart glasses featuring A33 system-on-chip, Bluetooth, wi-fi, and voice control, and pairs with a smartphone.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Fujitsu</td>
<td>Ubiquitousware head-mounted display</td>
<td>Head-mounted display comprises a small display, camera, two microphones, and sensors.</td>
<td>Available</td>
</tr>
<tr>
<td>Google</td>
<td>Curved display</td>
<td>Recent patents suggest the next generation of Google Glass may feature a curved display that will help users perceive depth.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Trimble Partners, Microsoft</td>
<td>Microsoft HoloLens and Trimble Connect, SketchUp, and V10 Imaging Rover</td>
<td>Integrating HoloLens head-mounted holographic display with Windows 10 with Trimble’s platforms to benefit the architecture, engineering and construction field.</td>
<td>Evolving</td>
</tr>
<tr>
<td>Vision Technologies</td>
<td>Smart glasses</td>
<td>Vision Technologies is developing software and created GiveVision.net to power smart glasses for visually impaired users.</td>
<td>Evolving</td>
</tr>
</tbody>
</table>

**Body-Worn**

<table>
<thead>
<tr>
<th>Company/Institution</th>
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<th>Description</th>
<th>Development Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlexEnable</td>
<td>Demonstrator flexible</td>
<td>Transistor screen technology that offers an electroluminescent</td>
<td>Evolving</td>
</tr>
<tr>
<td>Screen Technology</td>
<td>Display fit for the sleeve of an outdoor jacket.</td>
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<tr>
<td>Lenovo Magic View, Smart Cast, Smart Shoes</td>
<td>Magic View offers two screens. Smart Cast combines laser projection and infrared motion detection. Smart Shoes uses Lenovo’s cloud-backed internet-of-things ecosystem open software development kit in conjunction with footwear to track activity. Evolving</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Power

#### Self-Powering (Harvesters)

| Chinese Academy of Sciences Perovskite solar cell | Ultra-thin, bendable perovskite solar cells with the ability to convert greater percentages of solar energy into electricity Evolving |
| Commonwealth Scientific and Industrial Research Organization Flexible Integrated Energy Device | Wireless, wearable power source with energy-harvesting system that harnesses via the pack’s straps energy from the user’s body movements; a flexible battery; and washable fabric with conductive fibers that also connect to electronic devices. Evolving |

### Communications

#### Hands-Free

| Aria Wearable Aria Wearable gesture controller | Clip-on gesture controller clips to a smartwatch and allows a user to navigate the device using gestures. Evolving |
| Google ATAP Project Soli | Harnesses fine hand movements to allow users to interact with smaller screens and control smaller devices using gestures Evolving |

### Cameras

| GoPro Virtual reality device, quadcopter drone | A virtual reality device that uses six GoPro Hero cameras to create a spherical shot. The footage will be synced to the cloud, eliminating the need for memory cards. GoPro is also developing quadcopter drone that will take aerial footage. Evolving |
| Inobrand iSECAM-HD wearable security camera | Clip-on wearable camera that offers 8 hours of recording with its rechargeable battery, 32GB memory, 4G/3G/wifi/GPS connectivity, 1921x180 HD resolution, encryption, night vision, and a weatherproof structure (water proof, impact resistant, withstands -3C-55C). Available |
| Mobius Mobius wearable camera package | The standard Mobius Camera with a proprietary magnet mount and clip to mount it on a visor, dashboard, or even a bow, as well as almost any surface. The small camera (1.38 x 2.40 x .72 inches) provides 1080P HD video and audio and its 820mah battery offers 120 minutes of recording time. Available |
| Sony FDR-X1000V 4K Action Cam | Allows a user to monitor the device (up to 5 cameras) live via wifi on a wrist-mounted remote. The device features HD and 4k resolution, has a built-in stabilizer, and is waterproof to 3 meters. Available |

### Exoskeletons

| Alex Czech (individual) 3D-printed hand exoskeleton | 3D-printed hand exoskeleton, with 13 printed parts, weighing 173 grams. The device costs an estimated $8.16 to create, including plastic, nuts, and bolts. Available |
| Berkeley Berkeley Lower Extremity Exoskeleton (BLEEX) | Self-powered exoskeleton featuring powered anthropomorphic legs, a power unit, and a backpack-style frame for mounting loads. Evolving |
| Buckhead Shepherd Center Indego | a powered, lightweight (26 pounds) exoskeleton that mimics the movement of human legs, providing power at the hip and knees, essentially walking for the user. Evolving |
| Cyberdyne Inc. Hyber Assistive Limb (HAL)® | Load-bearing robotic suit that reduces a burden to the user by 40%. Evolving |
| Esko Bionics Industrial Exoskeleton | Lightweight (16 lbs) and powerless exoskeleton that users counterweights and a standard, sprung arm. Evolving |
## Technology Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advanced Firefighting Apparatus</strong></td>
<td>Powered exoskeleton to increase firefighter’s performance. The device is customizable, equipped with an impulse water gun system and joystick, and can operate for two hours.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Exoskeleton research</strong></td>
<td>Mathematical models of energetic performance and stability control for use in the design of lower-extremity robotic exoskeletons to accelerate the development of better-performing, lower-cost assistive devices.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Kinetic Operations Suit</strong></td>
<td>Offers a hard body-armor protection that covers 60% of the wearer and can stop rifling rounds. The device is load-bearing, reducing the weight to the users, and offers motorized actuators on each leg.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Exoskeleton</strong></td>
<td>Exoskeleton that attaches to the body and can be controlled by the wearer. The device detects the user’s movement and generates auxiliary torque to provide extra strength.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Mind-controlled dual-use exoskeleton</strong></td>
<td>Military-grade automated control and dual-use robotic systems that allow the user to carry loads up to 300 kilograms and features a neuro interface that will allow the user to control the suit through images.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Artificial muscles</strong></td>
<td>Exploring the use of high-strength polymer fishing line and sewing threat to create artificial muscles for exoskeletons.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Soft exosuit</strong></td>
<td>Uses specially designed fabrics, which are lighter weight and allow for greater movement.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>iType smartwatch</strong></td>
<td>Wrist-worn smartphone with an improved typing feature, as well as two navigation buttons, camera, SIM card, 240x240 display, 1GB RAM, 8GB storage, wifi, Bluetooth, GPS, and G-sensor connectivity.</td>
<td>Available</td>
</tr>
<tr>
<td><strong>Fatigue management</strong></td>
<td>Uses predictive analytics to measure fatigue and provide real-time medical alerts.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Digital Crosshairs I-Targeting Monocular</strong></td>
<td>Wireless targeting accessory for the Digital Crosshairs rifle scope night vision clip that transmits live video of the scope’s targeting field of view to a small wearable micro monitor attached to shooting glasses.</td>
<td>Soon to be released</td>
</tr>
<tr>
<td><strong>Ubiquitousware location badge</strong></td>
<td>Offers pedestrian-dead-reckoning technology using an accelerometer and standard GPS.</td>
<td>Available</td>
</tr>
<tr>
<td><strong>Project Jacquard</strong></td>
<td>Integrating touch and gesture interactivity into any textile using industrial looms, turning a garment into a touchpad.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Smartbelt</strong></td>
<td>Two-part device detects when a user is lifting and which muscles are being used, indicating to users when they may be at risk for injury. The device features a wristband and back-brace with interacting sensors that calculate the risk of injury and use LED lights and/or vibration to warn a user.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Personal-cooling technology</strong></td>
<td>Personal-cooling technology that uses infrared-transparent visible-opaque fabric (ITVOF) to provide passive cooling via the transmission of thermal radiation emitted by the human body directly to the environment.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>Embedded Nucleus® real-time operating system</strong></td>
<td>Comprehensive operating system and protocol support for Internet-of-Things devices and cloud connectivity, equipped with built-in power management support, memory space partitioning, and system-on-chip architecture.</td>
<td>Available</td>
</tr>
<tr>
<td><strong>First responder garments</strong></td>
<td>Clothing for emergency workers, with added protection against a range of hazards including fire, water, chemicals, jagged debris, etc.</td>
<td>Evolving</td>
</tr>
<tr>
<td><strong>SenseMe algorithm library</strong></td>
<td>Comprehensive sensor fusion algorithm library, including fusion, activity, transport, gesture, and device location algorithms.</td>
<td>Available</td>
</tr>
<tr>
<td>Company</td>
<td>Technology</td>
<td>Description</td>
</tr>
<tr>
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</tr>
<tr>
<td>ReVault</td>
<td>ReVault wearable cloud</td>
<td>Portable, wearable hard drive that syncs a user’s data from multiple devices. The device uses wi-fi and Bluetooth and comes in 32GB and 128GB capacity.</td>
</tr>
<tr>
<td>Samsung</td>
<td>Artik system-on-chip</td>
<td>Artik 1 will offer Wi-Fi, BLE, Zigbee, RFID and Bluetooth connectivity, memory, and a 9-axis sensor path in a 11.5 mm x 12.5 mm chip. The Artik 6 SoC will be a computer on a chip, reportedly the size of an SD card, 1.8 MHz processor, 16GB RAM, and typical range of sensors and radiofrequency function.</td>
</tr>
<tr>
<td>University of Exeter</td>
<td>Electronic textiles with embedded, flexible graphene electrodes</td>
<td>Embedding transparent, flexible graphene electrodes into fibers, creating electronic textiles.</td>
</tr>
<tr>
<td>University of Manchester</td>
<td>Printable graphene for wearables</td>
<td>Binder-free process for printing graphene ink with high electrical conductivity.</td>
</tr>
<tr>
<td>Wild Acre Metals, Nuheara</td>
<td>Hearing and speech technology</td>
<td>A hearing technology platform that combines speech augmentation software with spatial directionality and placement, Bluetooth connectivity, and app software components.</td>
</tr>
<tr>
<td>WiSeKey SA</td>
<td>NFCTrusted</td>
<td>Trusted near-field communications (NFC) technology, integrating security authentication and identification with wearable devices</td>
</tr>
</tbody>
</table>