The Pennsylvania State University
University Park Campus

AT&T: Our Connected Lives
The Internet-of-Things (IoT)

Design Team 3
Team MC3
Spring 2014

Submitted to:
Professor Berezniak

College of Engineering
School of Engineering Design, Technology and Professional Programs
Penn State University

28 Apr 2014
ACKNOWLEDGMENTS

Penn State University

- Dean, College of Engineering
  Dr. Amr Salah Elnashai
- Department Head, SEDTAPP
  Dr. Sven Bilén PE
- Course Instructor
  John Berezniak
- Laboratory Assistants
  Names and Majors

AT&T

- Name
  Dallas, TX
  208 South Akard Street, Dallas TX 75202

Other Plan Contributors

- Other Acknowledgements
  Name and Title
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION 1.</td>
<td>EXECUTIVE SUMMARY</td>
</tr>
<tr>
<td>SECTION 2.</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>2.1</td>
<td>PROJECT OBJECTIVES</td>
</tr>
<tr>
<td>2.2</td>
<td>PROJECT BACKGROUND</td>
</tr>
<tr>
<td>2.3</td>
<td>SPONSOR BACKGROUND</td>
</tr>
<tr>
<td>2.4</td>
<td>PROJECT DESCRIPTION</td>
</tr>
<tr>
<td>SECTION 3.</td>
<td>METHODOLOGY</td>
</tr>
<tr>
<td>3.1</td>
<td>IoT SYSTEM AND GOALS</td>
</tr>
<tr>
<td>3.2</td>
<td>SYSTEM MODEL</td>
</tr>
<tr>
<td>3.3</td>
<td>BASIC CONCEPTS</td>
</tr>
<tr>
<td>3.4</td>
<td>SYSTEM CONTROL</td>
</tr>
<tr>
<td>3.5</td>
<td>DAY-IN-THE-LIFE</td>
</tr>
<tr>
<td>3.6</td>
<td>DEVELOPMENT AND MARKETING</td>
</tr>
<tr>
<td>SECTION 4.</td>
<td>DISCUSSION</td>
</tr>
<tr>
<td>SECTION 5.</td>
<td>SUMMARY</td>
</tr>
<tr>
<td>SECTION 6.</td>
<td>REFERENCES</td>
</tr>
</tbody>
</table>
SECTION 1 EXECUTIVE SUMMARY

With the increased competitiveness in today’s sports, teams look to gain an edge in any way possible. Coaches want to optimize the performance of players on the field but are concerned for their safety as well. If there was a way to measure a player’s physical output while monitoring them to ensure safety, coaches would be able to rest players when needed. In addition, such a device would enable coaches to predict which players could have the most production on any given play. At MC3, we believe that we have designed a device that is capable of all this. The new device will measure many bodily functions of the player via various devices attached to their body. Functions such as respiratory rate, heart rate, and temperature will be collected and sent by radio frequency to a remote computer somewhere nearby the players. Once the data is received, it will be processed and analyzed by both the computer and the person at the computer. The computer will provide warnings when high body temperatures or levels of fatigue are displayed by the players. In order to obtain a solid idea of what a player can be pushed to physically, players will wear the devices during intense practices. The computer will store these numbers as a baseline in order to later recognize when a player is no longer performing at optimal level. Through development and funding, we can create a small device that will not impede the physical ability of athletes and will be able to measure bodily functions with extreme precision.
2.1 PROJECT OBJECTIVES. Identify opportunities that leverage real-time connectivity and new and emerging technologies to collect information that can be used for products and systems that benefit our lives.

2.2 PROJECT BACKGROUND. The Internet of Things (IoT) is a scenario in which objects, animals, or people are provided with unique identifiers and the ability to automatically transfer data over a network without requiring human-to-human or human-to-computer interaction.

Machine-to-machine (M2M) solutions wirelessly connect millions of diverse devices to a network, enabling monitors and vending machines, M2M allows network-ready devices to connect and share reliable real-time data via radio signals. Monitored and managed remotely, M2M automates processes in industries from transportation to healthcare.

2.3 SPONSOR BACKGROUND. AT&T is a premier communications holding company and one of the most honored companies in the world. Its subsidiaries and affiliates—AT&T operating companies—are the providers of AT&T services in the United States and internationally. With a powerful array of network resources that includes the nation’s fastest and most reliable 4G LTE network, AT&T is a leading provider of wireless, Wi-Fi, high speed Internet, voice and cloud-based services. A leader in mobile Internet, AT&T also offers the best wireless coverage worldwide of any U.S. carrier, offering the most wireless phones that work in the most countries. It also offers advanced TV service with the AT&T U-verse® brand. The company’s suite of IP-based business communications services is one of the most advanced in the world.

2.4 PROJECT DESCRIPTION. The project category which we worked under is “wearables”. Our area of focus is meant to measure the bodily functions of a human via a wearable device. The device will monitor and analyze the data and send the analysis to a computer. From there, a person whose job it is to man the computer will make decisions regarding whether or not a player should be in the game based on his or her health.
SECTION 3 METHODOLOGY

3.1 IoT SYSTEM AND GOALS.

The IoT system is a pad that is attached to the chest of an athlete. The pad is meant to measure pulse, respiratory rate, blood pressure and body heat. By measuring these, coaches will have an accurate idea of the fatigue and health of a player on the field. By doing so, they can prevent hazards to the player’s health such as dehydration or heat stroke while also preventing decrease in performance by substituting them when they are out of energy.

3.2 SYSTEM MODEL.

3.3 BASIC CONCEPTS. The data is collected by various monitors ranging from a thermometer to a blood pressure monitor to a respiratory rate monitor. These “wearables” are connected to RFID chips that wirelessly transmit the data to a computer that sorts and analyzes the data by player. The RFID is optimal for sports situations due to its minimal size and the optimal range that the wearable will operate at. The RFID operates within a few hundred meters which perfect for locations such as a stadium or practice field. The health benefits that
arise from the device include fatigue and heat-stroke prevention. By monitoring the physical output of players, intelligent coaches will be able to optimize lineups by utilizing more rested players. While one individual device is not expensive, combining the separate devices into one and sending the data to a single computer can be costly. Limitations include the inability to measure biological output to 100% precision.

3.4 SYSTEM CONTROL. The device can be controlled externally by a computer which would most likely be inside a room in the stadium. The person monitoring the computer would then relay the information to either the head coach or a personal trainer who will act accordingly. However, the system can easily be adjusted to send data to an iPad on the sidelines in order to more directly transfer the information. Control can easily be transferred as long as the user is knowledgeable of the system and how to operate it. A manual control option would be at the player’s discretion if they believe that they cannot function at optimally, or that their health is at risk. No data could be used in a criminal way, but the data may be vulnerable to interception by the other team due to hacking. By hacking, opponents can make use of the other team’s data to strike vulnerable players.

3.5 DAY-IN-THE-LIFE. In a year from now, the device will be used by only a few teams collecting as much relevant data as accurately as possible. The data will be used to form different algorithms to most accurately measure player fatigue. This early in the process may yield inaccurate measurements of fatigue. The device may also be adjusted to become more ergonomic. Five years from now, due to funding from marketing and development of technology, the device will become increasingly smaller and less cumbersome. It will more accurately measure, analyze and transfer data. Many professional sports teams will implement the device to better optimize player performance and health safety.

3.6 DEVELOPMENT AND MARKETING. Nike, Adidas, Under Armor would all endorse the product and market it, but the product must first be designed and constructed by bio-medical engineers. One company that is capable of this is Corventis; a company that specializes in the construction and research of many different biological monitors. Corventis has recently created a respiratory rate monitor that is placed over the heart instead of in the mouth to measure breathing rate.
Our final product measures blood pressure, pulse, body temperature and respiratory rate. Originally, we hoped to include a GPS so that we could track the speed and physical output of athletes and relate such data to their physical well-being. Much of our decision making process was based on technological limitations of the present day. For example, we hoped to find a way to measure dehydration, but doing so is very difficult unless the subject is hooked up to a large apparatus. Moreover, it would be counter intuitive to have athletes running around with bulky GPS’ simply to measure how fast they are running. While our system was designed for athletes, it does not have to be limited to pro sports. Perhaps another application would be for patients with high blood pressure to wear a small device that could wirelessly transmit data regarding their health to a smartphone app.
SECTION 5  SUMMARY

The main benefits of our design are health benefits. We aim to cut down on deaths among athletes and increase general health among professionals by cutting down on fatigue and making sure they are not pushed beyond their physical limits. However, these basic health measurements may be utilized by intelligent coaches and trainers to give their team an edge over the opponent. The strengths of our system include seamlessly tying together numerous biological factors and sending them to a single receptor. Our system’s weakness is its inability to measure all of the factors we want, and the fact that the system may be a little cumbersome at first. The advantages of our design have been discussed, and the only real disadvantage of our design is that some athletes may be uncomfortable with the “wearables” and their performance may suffer as a result. The system should also be used for at-home medical patients and those with known health problems that must be constantly monitored. Research should be focused towards finding ways to more accurately measure data as well as cut down of the size of the devices.
SECTION 6

REFERENCES

http://www.corventis.com/products/nuvant-mct/how-it-works/


http://www.healthchecksystems.com/lifesource_digital_blood_pressure_monitors.htm