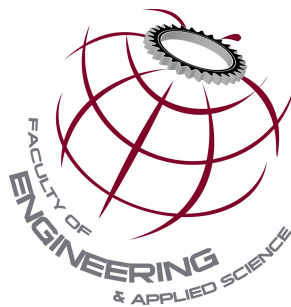# Computer Architecture of Wearable Technology (Draft)

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Executive Summary

@todo

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1   Introduction

Wearables as defined by Technopedia are technologies that are worn on the body that contain various sensors that can record health and fitness information, or take movement input data in real-time [1]. The market for this technology has expanded rapidly in recent years, with the wearable market being worth $19 billion in 2015, and expected to expand to $57 billion by 2022 [2]. This growth rate can be attributed to the fact that it is a novel technology just getting past the early adoption phase, but this technology is also improving at an impressive pace each year. The 2010s have seen advances in lower-powered processors with a smaller footprint that allow wearable devices to become much more powerful. With improvements in small, powerful processors, it allows wearables to have more functionality, and focus less on designing the wearable around the electronics inside [3]. Clearly, this demonstrates the design requirement for low-power and small components to architects of wearable technology.

While there are many types of wearables on the market in present-day 2019, this report will focus on two types of wearable technology: smartwatches, which record movement data for health and fitness purposes; and virtual/augmented reality (VR/AR) headsets and head-wear, which process movement data in real time for immersive digital experiences.

2 Smartwatches

2.1 Background

The most popular type of wearable in 2019 is the smartwatch [4]. Smartwatches are devices worn on one's wrist, equipped with sensors, and in some cases wireless communication capability for syncing data to a smartphone. They have rich operating systems (OS), on-board processors and memory, and come in a wide range of varieties from basic to high-end, with different specialized models in between [5].

2.2 Typical Specifications

Modern smartwatches typically have similar components to computers, albeit at a much smaller scale. They have an OS, which is most cases is proprietary to the manufacturer (i.e. watchOS for Apple); a single- or dual-core processor ranging from 80MHz to over 1.2GHz depending on the type of watch; up to a gigabyte of memory; battery life ranging between 18 hours to over a week; and depending on the watch - sensors to measure heart rate, fitness statistics, and atmospheric pressure [5].

It is simple to build a system that can accommodate all the required features of a smartwatch using normal computing components, however the challenge with a smartwatch is weight, size, and power consumption, as it needs to fit comfortably on the wrist, and be able to record data for at least an entire day on a single charge. This means all components must be lightweight, and energy efficient.

2.3 Analysis of Examples

Some common examples of smartwatches are the Apple Watch, and the Garmin Forerunner, both shown below in Figure 1. These devices are priced quite differently, carry different levels of functionality, and are targeted towards different segments of the market. Shown below in Table 1 are prices for the watches listed above [6] [7].

(a) Apple Watch Series 5 [6]

(b) Garmin Forerunner 235 [7]

Figure 1: Smartwatches discussed in this report.

Table 1: Smartwatch Prices

Watch	Price (CAD)
Apple Watch Series 5	529.00
Fitbit Charge 3	199.95
Garmin Foreruner 235	319.99

Clearly, these watches come at different price points, target different segments of the market, and of course come with different architectures for accommodating the necessary features in each model. This section will cover each of the watches shown above in greater detail.

2.3.1 Apple Watch Series 5

2.3.1.1 Background

The Apple Watch Series 5 is the newest iteration of smartwatch from Apple Inc., released in September 2019. Priced at $529, clearly this is considered a higher-end smartwatch,

fitting in with Apple's other product lines (iPhone, iPad, and Mac). This watch has all-day battery life, a touch screen, voice call, GPS, compass, and music streaming capabilities, as well as the ability to run thousands of apps from the Apple App Store, made specifically for the Apple Watch [8]. This device is made for Apple users, as it requires an iPhone to make use of all its features.

Much of what makes the Apple Watch quite appealing is the variety of sensor technology that can track much of your health and fitness data. This sensor technology will be discussed, along with other computer architecture components in this section.

2.3.1.2 Hardware

The processor and System in Package (SiP) at the core of the Apple Watch Series 5 is Apple's S5 chip, shown below in Figure 2. This is the fifth iteration of their custom-designed smartwatch chip where the entire system is fabricated into a single component [8].

Figure 2: Apple S5 Processor [9]

2.3.2 Garmin Forerunner 235

If its name wasn't obvious enough, the Garmin Forerunner 235 is first and foremost a runner's watch.

3   Virtual/Augmented Reality

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