The Internet of Things (IoT), a network of easily deployed sensors and smart devices, combined with advanced analytics platforms and cloud services, has the potential to disrupt and strengthen products and services across multiple industries. IoT is the convergence of more reliable and secure high-speed broadband networks, universal wireless internet, cloud computing, and sensor technologies that can collect and share data via the internet, and the emergence of big data analytics to store and dissect that data. Any standalone internet-connected device that can be monitored and/or controlled from a remote location is considered an IoT, or "smart," device. With the development of cheaper and more powerful sensor chips, virtually any product can be transformed into a smart device. Advances in sensor technology have enabled data collection from everyday consumer products (for example, watches and cars) and industrial items (for example, factory equipment or utility grids). This information is centralized on networks which support platforms used to enhance productivity and support new business services or applications to help secure health, safety, or environmental benefits for consumers and corporations.

Cloud computing is the delivery of elastic, on-demand computing power and data storage over the internet.

This emerging technology is in the early stages of development, and the number of potential applications could be tremendous. However, measuring the technology's long-term impact has been a challenge. The International Data Corporation estimates IoT-related global spending will hit a growth rate of 15.6% by 2020, reaching $1.29 trillion. Further, according to the NCTA—The Internet & Television Association, more than 50 billion smart devices will be linked to the internet by 2020, including such essentials as kitchen appliances, house security systems, and even subways (Chart 1). Today, consumer applications like Garmin’s fitness monitors and Amazon’s Alexa smart speaker may attract the majority of the public’s attention, but we believe industrial and commercial uses could be another powerful growth driver. Future consumer applications will likely focus on efficiency in everyday life and replace many of the more mundane tasks such as grocery shopping, preparing meals, landscaping, or automatically optimizing home heating and cooling based on current energy pricing. Together, consumer- and industrial IoT-related sales are forecast to reach $1.6 trillion by 2025.

1 “How 70% of Fortune 100 Companies Use the IoT,” Curator–Citi IO (October 3, 2017), https://www.citi.io/2017/10/03/how-70-of-fortune-100-companies-use-the-iot/.
Navigating the Adoption Curve: Sources of Internet of Things Growth

Evolution of IoT Consumer Applications

A few years ago, one would be hard pressed to predict how fast the consumer preference for **smart speakers**, one of the earlier innovations of sensor technology, would grow. But demand has skyrocketed, with consumers estimated to have purchased more than 56 million smart speakers from companies including Google and Amazon through 2018.4 Smartphones increasingly are becoming the personal gateway to IoT, serving as a remote control for the connected home, automobile, or even the fitness trackers popular among millennials. Finding keys, unlocking doors, turning the heat on, and other daily tasks can be automated with sensors and smart software. With wire coverage available worldwide, wireless connectivity has become relatively inexpensive, helping to fuel the expanding usage in smart devices.

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**Smart speakers** are basically “dumb” speakers connected with internet-linked sensors to better manage music listening preferences or function as home assistants.

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The ownership rate of smart devices is expected to climb, particularly in the realm of home automation to help reduce energy costs and improve security, for example. The smart home market had sales of nearly 644 million devices in 2018, a 31% year-over-year growth rate, and as many as 1.3 billion units are expected to be sold in 2022.5 Sensor-enabled products such as the Nest, which was bought by Google in 2014, allow homeowners to manage their homes from a remote location via an app on their smartphones to prevent break-ins, theft, or any other home-related issue like a fire before it gets out of hand. IoT products related to home energy management aim to promote energy efficiency by automating the operation of lights, appliances, and heating and cooling systems. The Nest Learning Thermostat, which “learns” a homeowner’s schedule and programs itself, claims to save the average consumer 10–12% on heating and 15% on cooling.6

In health care, smart medical devices have focused on improving patient outcomes and reducing costs by reducing the time spent in a hospital and by promoting preventive care. Technology designed to help the elderly live at home longer has become more relevant as the baby boom generation ages, for example, home medical dispensers that automatically upload data to the cloud if medication is not consumed. Smart technology has the potential to drastically reduce the workload and stress for health care providers by allowing them to remotely monitor a patient’s health while he or she is recovering at home and take quick action in the event of any major changes in the patient’s readings. The health care consumer trend is also being encouraged by millennial interest in staying healthy through the use of wearable fitness trackers, a market expected to double by 2022, hitting $27 billion in revenue and an estimated 233 million units sold.7 While these consumer products currently measure exercise, heart rate, diet, sleep patterns, and other factors, we believe they could eventually be used to relay information to health care providers, employers, or insurers.

Industrial/Commercial IoT Applications

Many people may think the internet’s greatest impact is on consumer applications, entertainment, and social media networks. But multiple industries worldwide have been implementing smart technology into their manufacturing processes. Industrial/commercial

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7 Hoffman, “The IoT Is at the Center of Disruptive Technologies.”
applications, including customer engagement and performance tracking, comprise the largest percentage of global IoT-related spending. Through the use of sensor technology and data analytics, there is potential to automate business and manufacturing processes, remotely monitor and control operations, optimize supply chains, and conserve resources. Corporations such as General Electric Company, Cisco Systems, Inc., Rolls-Royce, and AT&T Inc., have been early supporters of IoT as a means to help boost productivity and save on capital expenditures and on labor and energy costs.

According to Intel Corporation, “the business benefit of integrating an IoT sensor system are as varied as the industries that deploy these systems….sensors can monitor cooling systems to enable more efficient operation and reduce energy costs, collect air samples to help maintain ideal environments, and detect variations in a motor’s vibration to reduce failure.”

A recent example of this comes from Anheuser-Busch InBev, one of the world’s largest beverage distributors. The company has installed sensors within its packaging lines that can detect ultrasonic sounds (beyond the capabilities of a human ear) to predict when a machine will need maintenance. In real time, the sensors compare the sound to a normally functioning machine sound to pick up on possible abnormalities.

Consequently, we have seen a jump in fixed capital investment in software as opposed to traditional capital goods equipment, which has resulted in new business models that can integrate hardware and software offerings, stronger revenue streams, and enhanced customer retention. Seven of 10 Fortune 100 companies currently use IoT-related products, services, or initiatives, while 38% of global manufacturers are producing such products and services and 48% are in the process of developing them. We believe smart devices and the technologies supporting their application will help companies:

- prolong the life of assets;
- evaluate and enhance financial performance;
- boost operational efficiency; and
- act as a real-time data analytics platform to help steer long-term business strategies.

**Big Data**

Advancements in big data analytics have helped spur the rapid growth of IoT-related applications—database technology powered by specialized platforms and cloud software that can manage larger unstructured data sets more efficiently, quicker, and at less cost than traditional databases. As the quantity of and accessibility to big data have grown in the past few years, more organizations are evaluating how they can better leverage this information to make more effective management decisions and improve their bottom lines. Big data analytics is the process of breaking down large and diverse datasets to reveal major market trends, unknown patterns, obscured correlations, customer penchants, and other valuable information to help organizations make “smarter” strategic moves. Predictive maintenance and analytics have already gained significant attention in manufacturing and telecommunications by using sensors to collect data that can then be analyzed by algorithms. It is expected that by 2022 more than 80% of IoT capital projects will include an artificial intelligence (AI) element, a leap from only 10% in 2017.

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8 https://www.citi.io.
9 Ibid.
12 https://www.citi.io.
14 Hoffman, “The IoT Is at the Center of Disruptive Technologies.”
Big data analytics has been especially constructive for corporations in highlighting such factors as new revenue streams, more effective marketing strategies, enhanced customer service, improved operational efficiency, and increased competitive advantages relative to industry peers. For example, retail companies such as Wal-Mart Stores, Inc., have used analytics tools to study sales, pricing, economic, demographic, and weather-related data to modify product inventories at specific stores and influence the timing of price adjustments, and the industrial shipping company United Parcel Service, Inc. tracks data on truck delivery times and traffic patterns to decipher the best routes.

Looking to the future, the amount of data produced by IoT usage is expected to hit 4.4 zettabytes by 2020, up from just 0.1 zettabytes in 2013. We expect further investments in powerful analytical technologies as more companies migrate toward implementing smart device sensor technology in their day-to-day operations and long-term strategic plans.

Erik Casalinuovo, CFA®
Senior Investment Strategist

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17 Priceonomics Data Studio, “The IoT Data Explosion: How Big Is the IoT Data Market?”