The Internet of Things:

Applications and Challenges

In the last module, we discussed the basic technologies and concepts that make the Internet of Things a reality. Hopefully by now, you have a good idea of how IoT works. Now we will discuss the more practical side of IoT. In this module, you will learn about some of the major current and future applications of IoT, how they benefit humanity, and the challenges that they present.

By the end of this module, you should be able to:

02_Obj01: Identify the applications of IoT
02_Obj02: Identify major benefits of IoT applications in healthcare
02_Obj03: Identify the challenges of the Internet of Things
02_Obj04: Create a report about applications of IoT

Applications of IoT

All these ground-breaking concepts and cutting edge technologies mean nothing if they are not put to good use. Here are some of the most current and most popular applications of IoT.

Smart Devices

Smartphone tablet. (n.d.). Retrieved July 19, 2017, from https://pixabay.com/
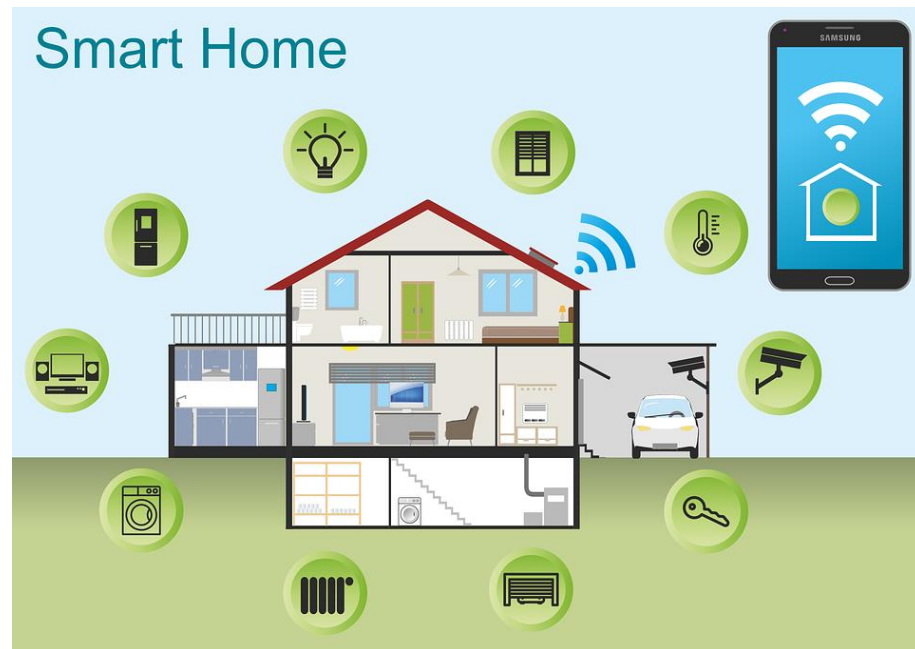**CC0 Public Domain Free for commercial use No attribution required**

The most widely used smart devices today are smartphones and tablets. A **smart device** is an electronic device which can connect to other devices and networks through different wireless technologies such as Wi-Fi, Bluetooth, 3G and perform different tasks such as playing and recording audio and video, communication, encoding, etc. Recently, even traditional household appliances such as televisions are being turned into smart devices.

Smart Watch. (n.d.). Retrieved July 19, 2017, from https://pexels.com/ CC0 Public Domain Free for commercial use No attribution required

Wearable devices or *wearables* are electronic devices that can be worn or attached to the user's body or clothing. Wearable devices are designed for different purposes; some have general functions such as running apps, playing music, and receiving calls while some have more specialized uses such as tracking the user's sleep, counting steps, monitoring heart rate, etc.

Smart Home

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A **smart home** or a **smart building** is a home or a building that is equipped with IoT-connected appliances and can be accessed and controlled remotely by the owner through devices such as laptops, smart phones, and tablets.

Here are some examples of smart home devices that can be incorporated to smart homes:

1. **Smart Speakers:** Have you ever watched a science fiction movie where the building or spaceship can talk to people? That's pretty much what a smart speakers aim to accomplish. A smart speaker is a device with a speaker and microphone and connects to a Cloud-based (to be discussed in the next module) virtual assistant service such as Amazon's Alexa and Apple's Siri. A smart speaker can follow commands and answer questions such as "Siri, play my favorite songs" or "Alexa, what does *bongiorno* mean?" smart speakers can also perform more complex tasks such as making online purchases.

Examples**:** Google Home, Amazon Echo, and Apple's HomePod

2. **Smart Lighting** doesn't just turn off and on. It can be programmed to react to its environment's lighting conditions. For example, it can turn itself on when it gets dark. Smart lighting's schedule, color, and brightness can also be adjusted via remote control and smart phone. Examples: Phillips Hue, Ikea Smart Lighting solutions.

3. **Smart Fridge:** A smart refrigerator has a touch-screen interface, internet connection, and cameras. It can monitor its contents and remind the user when an item is about to expire. It can also send pictures of its contents to the user so that the user can know which items need to be replenished. Examples: Samsung Family Hub, LG Smart InstaView

4. **Smart Air Conditioning** has sensors that measure temperature, humidity and sunlight and can access online weather data to manage the home's temperature. Smart AC can also analyze user input and "remember" which settings are most comfortable for user. Examples: tado° Smart AC Control, Ambi Climate

Smart City

A smart city utilizes IoT technologies in Urban Development. IoT-based infrastructure and services are used the assets of a smart city with the ultimate goal of improving the quality of life of its residents.

While "smart city" is still a relatively new concept, it is the general agreement that IoT will play an integral role in its day-to-day operation. The following are prime examples of IoT applications in a smart city:

1. **Water**: One of the most promising smart city applications of IoT is the management of valuable resources such as water and electricity. Smart sensors can gather information about the city's water distribution system such as temperature, consumption and water pressure. This will serve as valuable tools in managing a city's water supply and lessening wastage.
2. **Electricity**: We are used to the traditional power grid where electricity is delivered to our homes for us to consume then we pay a monthly bill. This one-way system is fast becoming obsolete due to increasing and rapidly changing electricity needs. A smart grid promises to change that. A *smart grid* is an electricity supply network where information, along with electricity, is exchanged between the suppliers and consumers. Instead of a just receiving a monthly bill, consumers will have access to real time information about their power consumption. Furthermore, homes with sustainable power sources such as solar panels can send the excess electricity that they generate back to the grid. This means that households will even be able to sell their excess electricity.
3. **Transportation:** In a smart city, public and private transportation will be managed by IoT-based systems. Many automotive companies are already utilizing IoT technologies. A *smart vehicle* or a smart car is a vehicle that features IoT based technologies used for navigation, safety, maintenance, entertainment, etc.
You are probably familiar with the Global Positioning System or GPS which is a network of satellites which can pinpoint the geographical location of objects with ground receivers. GPS is

already commonly used today, but as a part of IoT, it can be more useful.

For example, sensors installed in parking spaces can send information to an online network, giving motorists (located via GPS) the location of nearby vacant parking spaces. Furthermore, sensors and cameras in roads can send information to public and private vehicles regarding traffic congestion, road accidents, etc.

4. **Sanitation:** IoT is already being applied in sanitation. For example, iPEK a German pipeline inspection company teamed up with IDEX, a fluidics systems corporation to develop a cloud based (to be discussed next module) system that uses information transmitted by sensors and cameras installed in sewer pipes to inspect and manage sewers

5. **Governance:** The government can better monitor the goings-on in a smart city. IoT technologies can help the monitor the activities in public spaces and gather information that can be used to improve their services and policies. For example, Singapore is currently in the process of building a Virtual Singapore, which is a "*dynamic three-dimensional (3D) city model and collaborative data platform*". This online platform will be contain the collection of real-time data gathered by smart systems around the city. Virtual Singapore will be available to public and private sectors and can be used for research and testing sophisticated tools and applications.

IoT in Healthcare

Health is in everyone's list of top priorities. This is why it is not surprising that groundbreaking technologies and concepts such as the

Internet of Things tend to immediately find their way into the healthcare industry. Here are some of the most promising applications of IoT in healthcare.

Connected healthcare or connected care refers to the use of Information and communications technology, particularly IoT in the healthcare industry. The following are the major benefits of IoT in health care according to IBM:

1. **Decreased Costs:** Patients' health can be monitored at home via smart devices, decreasing the need for costly doctor visits and hospital admissions.
2. **Improved Outcomes of Treatment:** Real time and more comprehensive data gathering will help doctors make informed decisions. This can this can increase the chances of success of medical treatments.
3. **Improved Disease Management:** The spread of communicable diseases can be closely monitored. This can be an indispensable tool in preventing the outbreak of diseases.
4. **Reduced Errors:** more accurate data collection and the automation of medical processes can greatly minimize errors.
5. **Enhanced Patient Experience:** Reducing the time and effort needed to provide and receive medical treatment will make the ordeal less frustrating for the patients.
6. **Enhanced Management of Drugs:** Finally, IoT can also improve the way drugs are manufactured, prescribed and administered.

Challenges of the Internet of Things

Along with the benefits come the challenges. The following are the biggest issues facing the Internet of Things:

Security

What happens if the systems that run important services are attacked? For example, in December 23, 2015, Ukraine's power grid was hacked causing blackouts that affected more than 200 thousand people. According to investigators from the US, hackers sent phishing emails to power companies in order to steal logins and passwords for the virtually controlled systems that manage the power grid. The cyber attack caused up to 6 hours of power disruption in some areas and damages to the system that took months to repair.

Privacy

The Internet of Things requires the collection of a lot of information. Some of these information are private or extremely personal. Sensors, cameras, as well as GPS capabilities in smart devices can be used to monitor users' location, actions, and habits. Furthermore, many services require users to submit sensitive personal information such as pictures, addresses, and banking details.

Compatibility

In the previous module, we talked about different wireless technologies such as Bluetooth, Zigbee, and Z-Wave. These technologies are currently competing against each other. Eventually though, there will have to be a standardized protocol for machine-to-machine (M2M) connection just like how TCP/IP became the global standard.

Connectivity

The Internet of Things will involve billions, if not trillions of connected things. Even if IPv6 can secure enough addresses for all of these things, several other connectivity issues still need to be addressed. For one, if each household is expected to have hundreds of connected objects, then Internet service needs to be more affordable and more powerful. Furthermore, batteries for wireless devices need to be more efficient and wireless technologies need to have very low power requirements.

Glossary of Terms

SMART DEVICES – is an electronic device which can connect to other devices and networks through different wireless technologies such as Wi-Fi, Bluetooth, 3G and perform different tasks such as playing and recording audio and video, communication, encoding, etc.

SMART HOMES – is a home that is equipped with IoT-connected appliances and can be accessed and controlled remotely by the owner through devices such as laptops, smart phones, and tablets.

SMART CITY –   is a city that uses IoT-based infrastructure and services with the ultimate goal of improving the quality of life of its residents.

SECURITY - Its purpose is to create rules and measures to use against attacks over the Internet

WEARABLES – are electronic devices that can be worn or attached to the user's body or clothing.

IoT – or Internet of Things is a computing concept in which everyday objects are connected to the Internet.

URBAN DEVELOPMENT – development of improvement of an urban area.

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Links to Videos and Readings

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