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Internet of Things

The Internet of Things is the future of the internet. Internet of Things (IoT) refers to the interconnecting of billions of devices and giving them the ability to talk to each other. (What is the IoT? Everything you need to know about the Internet of Things right now) This includes many devices that aren’t traditionally thought of as being connected to the internet, such as a watch or a picture frame. There are many devices already in use that are a part of the Internet of Things. These include; smart cities, smart homes, and self-driving cars.

The idea for IoT, has been around since the 1980s. The term “Internet of Things” was coined in 1999 by Kevin Ashton. (What is the IoT? Everything you need to know about the Internet of Things right now.) Despite this, IoT is still in its early stages of development. There are two reasons why IoT has taken so long to develop; cost and lack of available IP addresses. Adding sensors to billions of devices in the 1980s was not worth the cost, but the cost of technology has continued to decrease every year. This has made it feasible to start talking about building these sensors.

An IP address is how devices on the internet talk to each other. This is analogous to a person’s home address where they receive mail. Just like a person needs an address to receive a letter in the mail, a computer also needs an address to send and receive mail. The computer does this with an IP address. IPv4 has been the standard for IP addresses for many years. There are a maximum possible 4.3 billion IPv4 addresses, but in 2017 there were already 8.4 billion IoT devices. (What is the IoT? Everything you need to know about the Internet of Things right now.) This is not enough IP addresses to connect every IoT device. Fortunately, IPv6 is replacing IPv4. With IPv6 there are more than 160 undecillion available IP addresses. That’s enough IP addresses for every grain of sand on earth to have one!

Now that the two main drawbacks of IoT have been addressed, more IoT devices are now being developed. There are currently billions of sensors in use with billions more being produced. The number of IoT devices is projected to grow to 20.4 billion by 2020. This will be split among consumer and business products. Spending on IoT devices in both markets in the year 2018 is projected to reach $772.5 billion. $239 billion of this total is projected to be spent on sensors. (What is the IoT? Everything you need to know about the Internet of Things right now.) IoT is becoming so popular that San Jose State University is now offering a degree in it. Three common applications of IoT are smart cities, smart homes, and self-driving cars.

The term smart city refers to a city which uses different types of electronic data collection sensors to supply information which is used to manage assets and resources efficiently. (What is smart city?) Besides this definition, what a smart city is and how it will be used is still unclear. There are many different possibilities. The main idea of a smart city is a city whose devices talk to each other and share information to improve or make more convenient the lives of its citizens.

There is still debate over the method which smart cities IoT devices will connect to each other. Smart cities are likely to be connected using Wi-Fi. One possibility is to add Wi-Fi to street lamps so that people walking on the street can have a continuous connection to the internet. This would also enable the smart cities IoT devices to communicate. (Smart city.)

Two types of smart city devices are smart cameras and smart street lamps. These devices can automatically turn on when they sense someone approaching. If no lighting was needed, then the lights could simply remain off which would save a lot of electricity. The security cameras raise privacy concerns, but some welcome the idea due to the potential decrease in crime. Criminals are far less likely to commit crimes if they feel that someone is watching them. (What is smart city?)

Smart cities can save lives by offering more advanced control of traffic lights. First responders can already change traffic lights, but in a smart city, their entire route could also be planned for them. Imagine an ambulance connected to the city in such a way that it has real time information about its own location, its target location, the fastest route possible, and traffic lights which can change to green when the ambulance is a block or more away. In addition to this, imagine that the cameras have facial recognition software which can identify the victim and transmit medical history to the ambulance personnel. This could help them potentially diagnose the patients’ medical emergency and have a solution for them before the ambulance even arrives.

Some additional Smart City applications are; smart parking, structural health, and traffic congestion control. Smart parking would enable the city to send information to a driver’s vehicle and tell them where the closest parking spot is. This is especially useful in large cities where parking is chaotic. Structural health will tell the city the condition of a building over time. This can alert the city when a repair is needed or when the building is no longer safe. The same is true for bridges. If a bridge is hit by a boat, the smart structure could send information to city personnel about the internal damage that was sustained during impact. Smart cities can reduce the amount of traffic by having more accurate traffic lights. If every IoT device is talking to each other in a smart city, then the traffic lights would have advanced knowledge of where traffic is before it arrives. This would allow the traffic lights to make smarter decisions regarding how long to leave lights green. (What is smart city?)

A smart home is like a smart city. It is meant to allow devices in your home to talk to each other and automate processes for the owner. Smart homes aren’t typically built completely “Smart”. What makes them smart are the devices which are added to them. (What is a Smart Home?) There are currently many devices available for purchase which can turn a regular home into a “Smart Home”. The most popular smart home device is currently the smart speaker like Amazon's Echo, but there are also smart plugs, smart lightbulbs, smart cameras, smart thermostats, and a smart refrigerator. (The Best Smart Home Devices of 2018.)

A smart plug allows the user to control their electronic devices from their smartphone. There is also a device called a universal remote which allows the user to control every smart device in their home from the same remote control. Smart home surveillance cameras have automated sound and motion detection, and free iCloud storage. There is also the SkyBell HD video doorbell which lets the owner speak to whoever is at their door. It also records audio and video. (The Best Smart Home Devices of 2018.)

There are many reasons to purchase a smart home or turn an existing home into a smart home. The main advantage is convenience. With IoT and smart homes, devices are now connected and talking to each other. These devices can now do things on their own that the home owner no longer must do. An example of this is Amazons Echo. The Echo is voice activated and can process commands from its owner. The Echo can quickly look up information on the internet. This saves the owner time.

Another advantage to owning a smart home is that they conserve Earths resources. The Smart Home does this by controlling lighting, window coverings, HVAC, irrigation, and by monitoring usage (What is a Smart Home?). Some of these features the home can automatically adjust by itself such as air conditioning and lights when they are not in use. For other features it can monitor usage and provide that data to the owner so that they are aware of their usage and resource consumption.

There are several issues concerning Smart Homes. One issue is that because many smart home devices are connected, if one device malfunctions then other smart home devices will malfunction too. For instance, one user reported that her smart thermostat was connected to her smart lights. When the thermostat was set to “away”, the house would turn the lights on and off based on a schedule. When she returned home and forgot to turn off the away setting on her thermostat, her lights would automatically turn on at 6pm and 7am, and she didn’t know why. Another issue was when her Philips Hue software scheduled her wake up call 4 hours early. (5 reasons why the 'smart home' is still stupid) The main complaint in both examples was that there wasn’t an interface that she could look at which showed her that these settings were configured. However, as smart home technology continues to grow, it is likely that there will be a solution for these issues such as a smart device which shows all the smart home’s currently enabled settings.

Self-driving cars are another big topic in IoT. There are different kinds of self-driving cars which are based on their level of “autonomy”. They range from 0-5. With 0 meaning completely controlled by a human, and 5 meaning the car is completely capable of self-driving in every situation. Currently there are no level 5 autonomous cars available, but it is possible that level 4 autonomous vehicles are going to be released within the next few years (Self-driving cars explained). There are many big-name car manufacturers which are currently working on driverless cars including; Ford, GM, Toyota, Honda, Volkswagen, Nissan, Volvo, and BMW. These companies are working with tech companies such as Intel and Nvidia to build these vehicles. Companies have invested an estimated $80 billion and years of work into self-driving cars. (Driverless Cars Explained)

Self-driving cars are a part of the IoT because they will be connected to other IoT devices using GPS and some type of sensors. The exact type of sensors which will be used have not yet been decided. Self-driving cars create and maintain an internal map of their surroundings which use sensors. Google is currently experimenting with lasers, radar, high-powered cameras, and sonar. (Self- driving cars explained) Before putting these cars on the streets, Google starts by using a simulator. This simulator allows the cars to drive virtually so that Google can experiment with different kinds of real-world scenarios. (Driverless Cars Explained)

There are many advantages to making all cars on the road fully autonomous. However, these advantages would not be experienced until about 10 percent of the cars on the road are self-driving, and the major advantages would require 90 percent of cars on the road to be self-driving according to the Eno Center’s study (10 Benefits of Self-Driving Cars). The reason for this is because most of these benefits rely on the fact that self-driving cars are fully aware of what other self-driving cars around them are doing. Some of these benefits include; fewer accidents, decreased traffic congestion, increased highway capacity, and higher speed limits.

Self-driving cars will all be connected to each other, which will allow synchronization of driving. This means that every car will know where the cars around them are going, and what they are doing before they do it. This one feature alone is one of the biggest advantages in self-driving cars because it eliminates the needs for drivers to have to try to interpret what other drivers are thinking and what they are going to do. This is especially useful because many of todays current drivers do not follow basic driving laws such as stopping at red lights and stop signs and using turn signals. Because of the connection of self-driving cars, speed limits would be increased because every car would be traveling at the exact same speed. This would make driving safer and would reduce the need for lower speed limits. The stopping distance required to avoid collisions would be reduced. This is because there would be exact synchronicity in driver’s breaking. Self-driving cars would break simultaneously which would bring the stopping distance from about 120 feet, to only 16 feet! (10 Benefits of Self-Driving Cars) This synchronization would also increase highway capacity while reducing traffic congestion! This is because most traffic jams are due to selfish driving habits and poor driving judgement which would be eliminated with self-driving cars.

There are concerns with self-driving cars, as there are with many IoT devices. The main concern with self-driving cars is safety. People are concerned that self-driving cars are not as safe due to the possibility of equipment failure. Although current vehicles have the possibility of mechanical failure, the risk is greater with self-driving cars because if the sensors or GPS system within the vehicle malfunction, the vehicle could crash. (Self-driving cars explained) Also there is concern over the decisions which a self-driving car must make. If there exists a scenario where a self-driving car is going to crash, and it must make a choice between saving the life of its passengers or saving the lives of pedestrians or passengers in another vehicle, what choice should the car make?

Security and privacy are the two biggest concerns with IoT. These apply to all three previously mentioned IoT concepts; smart cities, smart homes, and self-driving cars. With many interconnected devices, security vulnerabilities can place lives at risk. With all these smart devices talking to each other there is more internet traffic being sent, and therefore more internet traffic which can be intercepted. Hackers today are already able to use packet sniffing applications such as Wireshark to monitor and intercept data traffic. Now if a hacker was able to apply this technology to devices such as smart cameras, people’s privacy could be in jeopardy. Even scarier than losing privacy is the threat of smart technologies being hacked and taken over. This is a major security risk. If a hacker was able to remotely gain access to smart devices such as; self-driving cars, smart traffic lights, or smart ovens. Peoples lives could be at risk. Currently, IoT has very little security. Even basic security such as encrypting plain text is not being used. (What is the IoT? Everything you need to know about the Internet of Things right now.)As IoT continues to grow this is an issue that is going to have to be addressed.

The Internet of Things is the future of the internet. Smart cities, smart homes, and self-driving cars are three primary applications of the Internet of Things. They all have many advantages. Besides offering automated street lamps and providing Wi-Fi throughout a city, a smart city can save lives by providing first responders an accurate GPS location of someone in distress, as well as more advanced automated control of traffic lights. Smart homes enable the automation of household chores. They also consume less power and take advantage of renewable energy, so they are better for the environment. Self-driving cars offer more time to work on projects while commuting, and potentially less accidents due to the removal of human error while driving. While all these ideas offer more convenience for the population, they all have their share of security risks and privacy concerns. This is the reason that fully autonomous cars are still years out from being released to the public. As time goes on and technology continues to grow, people will have to decide whether the convenience of smart cities, smart houses, and self-driving cars are worth giving up their privacy and potentially their security.

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