

The Internet of Things and the Rise of Smart Cities

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Unless you've been stuck under that proverbial rock for a few years, you've at least heard of the Internet of Things (IoT) and how it is connecting us in new and interesting ways. The rise of the smart home is one way that the IoT is changing things for people around the world – homes filled with devices that can communicate with one another, with people living in the home, and even with outside third parties (think a refrigerator automatically contacting a grocery store when key items like milk or eggs run low to order more).

Of course, there are many other applications where smart technology is making our lives simpler, such as:

- Remotely programmable thermostats
- Remotely operable lights
- Remotely operable garage doors
- Whole home hubs that connect all devices with our smartphones and tablets

However, this technology is not constrained just to our homes. It's growing in terms of both scope and capabilities. Enter the smart city, where the Internet of Things will impact everything from lighting to the flow of traffic through urban centers.

What Is the Internet of Things?

While you're likely familiar with the notion of the IoT, what is it, actually? Chances are good that you can think of many things that connect to make this network, but what is the underlying concept here? Actually, there is no broadly accepted definition of what the Internet of Things is.

[Forbes](#) has one of the more apt descriptions of the IoT, though, which is, “the concept of basically connecting any device with an on and off switch to the Internet (and/or to each other). This includes everything from cellphones, coffeemakers, washing machines, headphones, lamps, wearable devices, and almost anything else you can think of. This also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig.”

From this, we can see that the Internet of things is not so much a physical thing, or even a formulaic process. Rather, it is a concept, and a somewhat nebulous one, at that.

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What Is a Smart City?

Unsure what a smart city might be? Don't feel alone. There is actually no single definition out there, nor is there a uniform way in which smart technology is being used within the infrastructure of global cities.

Perhaps the best definition of what a smart city is comes from the IEEE's Standards Association. The [IEEE](#) says, "As world urbanization continues to grow and the total population expected to double by 2050, there exists an increased demand for intelligent, sustainable environments that reduce environmental impact and offer citizens a high quality life. A smart city brings together technology, government and society to enable a smart economy, smart mobility, a smart environment, smart people, smart living and smart governance." Obviously, that is less than concrete.

Because of this ambiguity and disparity, we need to turn to actual use cases to determine what defines a smart city. There are quite a few ways in which this sort of technology is being utilized today around the globe, including the following:

- Sensors built into bridges to sense things like degradation and the effect of seismic forces at work.
- Sensors built into roadways to sense things like subsidence and wear and tear, as well as traffic flow.
- Sensors built into buildings to sense things like the force of wind, foundation subsidence, seismic activity, and more.
- Sensors within the interior of buildings to sense the presence of people within rooms, and thereby control the use of lighting, heating and air, and other systems to limit energy expenditure when it is unnecessary.
- Sensors at entryways to provide facial recognition for better security within apartment buildings, commercial buildings, government offices, and more.

These are just a fraction of the ways that smart technology can be utilized within a city to make it "smarter". What, however, are the primary drivers behind the push toward cities embedded with improved, "smart" technology?

What's Driving the Push Toward Smart Cities?

At first glance, the rush towards IoT adoption seems to be one of mere convenience, similar to the use of smart technology within a home. For instance, no one really needs a refrigerator that can reorder groceries when the on-hand supply gets low. It's mere convenience.

No one really needs a toaster that's connected to the Internet. It's just a convenience. No one really needs a [frying pan that connects an app](#) on your smartphone. Again, it's just convenience (and not so much of that in this case).

It's like the remote for your television – you are perfectly able to get up, walk to the TV and change the channel manually. It's just more convenient to do it from the comfort of the sofa.

The same concept does not apply to the integration of smart technology within city infrastructure. Here, it's more about achieving important goals, such as improving the use life and management of infrastructure, enhancing resident safety, and cutting costs and energy usage to be greener. To really understand the rise of smart cities, we need to delve into some of the drivers behind the adoption of this technology.

- **Infrastructure Management and Maintenance:** Many cities around the world are suffering from decaying infrastructure. Roads are degrading. Railroad tracks are decaying. Bridges and overpasses are aging and becoming unsafe. IoT technology can embed sensors in these areas to determine a broad range of things, including the extent of degradation, daily traffic flow increases, temperature extremes that may exacerbate damage, safety issues that could lead to mass injuries or loss of life, and more. Simply put, by utilizing IoT technology, cities and municipalities can better monitor the condition of their infrastructure, and manage those resources better, leading to improvements in safety, replacement costs and frequency, and more.
- **Security:** As mentioned previously, IoT technology allows the addition of new security features to buildings, offices, residential homes, and more. Facial recognition systems are just one aspect of this. As populations grow, the need for improved security also increases – biometric systems offer the means to improve security and safety for homeowners, business owners and workers, government employees and many more. There's a lot more that is possible, too. For instance, New York City has experimented with smart technology that automatically detects gunshots, helping to improve emergency and police response times.
- **Reduction in the Use of Energy:** Our cities are hungrier for power than ever before. Much of this energy is drawn from non-renewable sources, such as coal. Even cities with access to relatively

renewable resources, such as hydropower, or nuclear power generation can benefit from a reduction in raw demand. IoT technology offers an immense capability to reduce energy consumption, particularly wasted energy lighting and heating/cooling rooms people are not currently using. By focusing on zoned lighting/heating/cooling, cities can dramatically decrease their demand on the energy grid.

- **Improved Communication Capabilities:** The development and installation of smart networks allows improved communication capabilities from virtually all areas of a city. It is possible for things like traffic lights to communicate with the city council or responsible agency, and for grids within city parks to communicate with the parks department. It also improves access to information, allowing city departments to respond to changes with greater speed and accuracy. For instance, if a pothole opened in a section of roadway, the council would be alerted to the situation immediately, rather than waiting weeks, or even months, until a city employee manually inspected the area.
- **Emergency Preparedness and Environmental Awareness:** Smart technology within cities can be instrumental in emergency preparedness and improving environmental awareness. For instance, remote sensors could detect things ranging from changing barometric pressure to wind speed/shear and help predict weather changes.
- **Traffic Flow and Congestion Prevention:** One of the most important drivers of cities adopting smart technology has to do with managing traffic flow. Today's cities are mired in traffic congestion, but IoT technology has the ability to better manage traffic flow within urban centers and on highways.

Sensors can communicate everything from the number of vehicles passing a specific spot to the weight of vehicles driving over them to the speed of vehicles and more. This can play a role in achieving important outcomes such as reducing traffic snarls, cutting down on the amount of time commuters must sit in gridlock, and even potentially eliminating the most negative impacts of rush hour completely.

Improved safety, improved road management and maintenance, reduced time spent waiting – these are just the tip of the proverbial iceberg. For example, New York City invested in smart sensors with the goal of determining where drivers most frequently made sharp turns and hard stops, which is allowing them to determine what areas need changes made to the environment to reduce the potential for accidents and congestion.

While all of these drivers are important reasons for the adoption of smart technology within cities, the drive to better manage traffic is one of those with the most immediate impacts, which has made it one of the most common starting points for cities interested in experimenting with IoT technology.

The IoT and Traffic Situations in Our Cities

As you can see from the explanation above, smart technology is already having a major impact in one area of city life – traffic. It has already been used by many cities in the US to achieve important goals, and will be implemented by many others within a short period. In this section, we will look at some of the most important current use cases and their benefits, as well as vital ways that smart cities will make use of IoT technology in the future to better manage traffic flow and prevent congestion on surface streets, highways and motorways.

The Situation Today

At this moment, our cities are experiencing population surges. That leads to more and more vehicles on our roadways – residents getting to and from work, delivery trucks making their rounds, shipping companies delivering goods, service providers driving to reach clients, city buses helping residents who do not own vehicles, and more. All of those vehicles on the roads lead to problems, including:

- Longer waits at stoplights
- A dramatic increase in accidents
- Longer wait times for commuters
- Longer periods of gridlock – the growth of rush hour to cover most of the day in many cities
- An increasing number of wrong-way drivers on one-way streets
- An increase in the amount of debris on roadways (leading to accidents)

According to a story [published in Newsweek](#) at the end of 2017, the National Safety Council stated that there were almost 80,000 people killed on US roadways in 2015. Almost 4.5 million people were injured in road-related accidents. This led to \$152 billion in costs and losses for the nation, solely related to those accidents and not including regular road work and maintenance, new road construction costs, and the like.

Smart technology can help reduce those numbers and the associated costs by a significant amount. In some cases, it already is. Here are a few of the most interesting (and important) current uses of IoT technology by cities in the US and around the world related directly to traffic flow/congestion/safety.

Kansas City, Kansas: Kansas City is now employing a combination of CCTV cameras (both manned and software powered) and image-processing from a company called TrafficVision. The system focuses on collecting data and detecting incidents in real time. In a comparison, the automated system was able to detect incidents up to 14 minutes sooner than human operators were, and it was able to identify a host of potential issues affecting drivers, ranging from the presence of debris on the road to wrong-way drivers to

current accidents and more.

This allowed decision makers to come to instant decisions and react appropriately far sooner than they would otherwise have been able to, and allowing them to reroute traffic, change traffic light patterns, alert emergency services and generally improve road safety in myriad ways.

San Diego, California: The city of San Diego is using a combination of Internet-connected cameras within their traffic lights and streetlights to monitor things like pedestrian traffic. This has actually allowed the city to start rerouting vehicle traffic when heavy flows of foot traffic are present, and reducing the number of pedestrian/vehicle accidents in the city during peak travel hours. It has also enabled a smoother flow of vehicle traffic, as drivers are rerouted to areas where they are not forced to wait for as much foot traffic to cross the road, leading to less congestion overall.

Copenhagen, Denmark: The city of Copenhagen has a significant amount of bike traffic, as well as vehicle traffic and foot traffic. A network of smart sensors now allows city officials to monitor bike traffic in real time. Based on this information, traffic rerouting can occur, improving the flow of traffic for everyone. However, the data is also allowing the city to build a more comprehensive image of where the most bike traffic takes place, and how bike traffic is evolving. This then fosters the ability to build a better bike-specific infrastructure (new bike routes), which is important, considering the fact that over 40% of the city's population bikes to work every day.

London, England: London is using smart technology to improve parking capabilities for residents, businesses and visitors. The system in place now allows drivers to locate open parking spots easily, preventing them from having to drive around manually looking for open parking spaces. This helps to streamline traffic flow, alleviates some congestion, and reduces time spent waiting on parking.

Paris, France: Paris has one of the more interesting Internet-connected traffic solutions currently in use. In 2011, the city began building a fleet of GPS-connected electric vehicles for a car-sharing service. Since then, the fleet has grown to 3,000 individual vehicles. Consumers can track vehicles in their area by GPS in a smartphone app, allowing drivers to snag open vehicles when they are done being used. Each car also has an in-dash control center that allows the driver to reserve open parking spaces.

As you can see, there are plenty of ways that connected smart technology is already being used in cities around the world. There are also many other ways that are being implemented, or are being considered for implementation when other technology is in place.

Adaptive Traffic Signals

One of the simplest, yet most beneficial types of smart city technology is the humble traffic light. When connected to the Internet, these become adaptive, allowing timing to be changed depending on the time of day, the volume of traffic, and other factors, such as the flow of pedestrian traffic, special events, and more. This obviously affects how long vehicles sit at red lights, but it can also affect a wide range of other factors, including:

- Wait times for other travelers, such as pedestrians and cyclists
- Emissions from gas and diesel engines while idling
- Length of time “rush hour” lasts in a city
- Streamlining traffic flow during non-peak hours such as left on red when flashing/no oncoming traffic

The Growth of Smart Corridors

Smart corridor is the name given to specific areas of road networks heavily embedded with smart technology to achieve multiple goals. For instance, there is a stretch of interstate in Wyoming that is heavily used by both commuters and by shipping/distribution companies. Another example would be I-285 around the city of Atlanta, which experiences major delays due to its use by both 18-wheelers and passenger vehicles.

Smart corridors use a wide range of technology to create adaptive capabilities. Adaptive traffic signals are just one example of this technology. Others include smart speed limit signs that increase or decrease depending on traffic flow, time of day and other conditions, automatic lane closures depending on specific conditions, the use of smart cameras, real-time weather updates from short-range communication devices, and more. Ultimately, smart corridors can increase driver safety (both commuters and truck drivers), as well as reducing travel time and emissions.

Toll Changes

Toll roads are nothing new, but the ability to charge different tolls based on driving conditions is. There are many examples of these systems in place, including Atlanta, Georgia. This system charges a toll for exiting from the express lane, and the fee varies based on the time of day, the day of the week, the demand for the exit, and other factors.

Real-Time Tailoring

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One of the most interesting aspects of smart technology is the ability to combine smart sensors with artificial intelligence. This creates the ability to tailor driving situations to the prevailing conditions. As was proven in Kansas City, automated systems are capable of reacting to situations many times faster than human operators, allowing smart systems to create tailored driving scenarios in cities and on highways based on real-time factors as they develop.

- Kansas City uses a streetcar that is free to ride, and is embedded with smart technology. Commuters can access real-time information about the streetcar's location to get on board, and the streetcar can be routed as needed depending on demand.
- Adjusting traffic flow for special events, such as sporting events, concerts, and the like, helping to prevent automobile congestion due to increased foot traffic.
- Adjusting traffic flow via stop lights based on road conditions and situations. For instance, traffic could be automatically routed right or left at an intersection of the section ahead where overwhelmed with traffic due to an automobile accident.
- Traffic lights can be delayed when sensors detect pedestrians still in crosswalks when the light is about to change. Delaying the change improves safety.
- Walk/don't walk lights can be delayed based on the flow of automobile traffic on the roadway, helping to reduce vehicle traffic while still allowing foot traffic.

In Conclusion

The Internet of Things is here to stay, and nowhere is that more apparent than in the adoption of smart technology within cities around the world. While it might not be universal yet, adoption speed is increasing as the significant benefits of smart technology become better understood and access to this technology becomes more widespread.

Source:

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