ACHIEVING EXCELLENCE WITH REAL-TIME GIS AND IoT

With every passing day, Internet of Things (IoT) is gaining popularity across industries such as smart cities, public safety, agriculture, healthcare, utilities and transportation. With increase in IoT applications, numerous devices are getting connected together, generating huge volume of data in real-time. To make sense of such a large volume of data, seamless integration of location capabilities of the devices is required, and this is where GIS plays an indispensable role in enabling the IoT ecosystem. It is only through integration of GIS and IoT that businesses can utilize real-time data for most effective business outcomes.

IoT can be best defined as "The network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment." When businesses analyse the data captured by IoT, location plays an important role in the process. It is vital for the businesses to be able to tie all the information to 'where' things are happening and this makes 'The Science of Where', a major component of the entire process. The data that can be collected through GIS analysis can yield automatic reports, and those can greatly assist businesses in performing the aforementioned assessments and making relevant decisions. GIS could also be used to enhance existing IoT practices. GIS integration with the IoT may also lead to entirely new practices, leading to more efficient business outcomes.

As Jack Dangermond, Founder & President, Esri, says, "Sensor data collected in the Internet of Things ecosystem requires context to understand and make valuable. Geolocation provides that context, by transforming the raw data into useful information and ultimately actionable intelligence."

The application of GIS to IoT can bring exemplary results in almost every field. To understand how, let's consider a few examples.

Smarter solutions with real-time GIS and IoT

We are moving into a 'smart' world and it can become a reality only through effective integration of GIS and IoT. Each and every smart solution has IoT as a component. Sensors are providing us real-time information, for instance environmental sensors are telling us the level of pollution in a city, but that real-time value of 440 or 230 on its own does not have much relevance to a common man. However, if that value is combined with a GIS-based app and it gives an alert that a particular route is showing high level of pollution and thus should be avoided, then it brings in value to a common traveller. This is the power of integrating IoT and GIS, this integration can give us the best of both the worlds.

By bringing in IoT and GIS on a common platform, we can have smarter solutions for solving common problems. In smart cities, a network of sensors, cameras, wireless devices, data centres form the key infrastructure, which allows civic authorities to provide essential services in a faster and more efficient manner. Real-time streaming data capture infrastructural conditions, human movements, market transactions and many other activities that flow and interact in the cities. These real-time GIS data take the pulse of the smart cities, offering new insights on how the cities are functioning in time. They become invaluable resources to support informed and intelligent city planning, economic modelling, real-time traffic predictions and decision making.

Like smart cities, smart office campuses are also using IoT-based data streams, real-time processing and location intelligence to run the facilities most efficiently. On these smart campuses, facility managers can see in 3D not only the location of fixed and mobile assets, but also their status. GIS technology brings these 3D dashboards to life, allowing managers to see things in real time and decide by precise location which asset where needs immediate attention.

Better transportation through Real-time GIS and IoT

Digital wave has changed the way IT is supporting organisations and individuals. IoT is a component of the entire digital ecosystem. GIS has embraced each of these technological developments and has identified the touch-points where it can significantly contribute.

Getting the location of a moving object is one thing but tracking entire fleets of vehicles in real time allows moment-by-moment decision-making for improved operational awareness. By integrating advanced driver-assistance systems software with mapping, analysis, and visualisation, cities are able to visualise and analyse real-time location data. This helps in improving safety for all road users in urban environments.

Another excellent example of achieving better outcomes with integration of real-time data and GIS is the Remote Monitoring and Management of Locomotives and Trains (REMMLOT) system incorporated by the Indian Railways.

As part of this project, Indian Railways has put sensors in about 1700 of its diesel locomotives. Through this system, every 10 minutes real-time information is sent to a central control room, from where they can monitor the health of a locomotive in real-time, and thereby decide what action to be taken for its maintenance. As per usual maintenance schedule a locomotive goes for preventive maintenance every 90 days, however, with real-time data, they could be sent for maintenance if a need is identified earlier. One of the parameters that Indian Railways observes is location. That's where GIS comes into picture. They can locate where a locomotive is and which is the nearest workshop where it can be sent for maintenance. This helps in faster, more informed decisions and results.

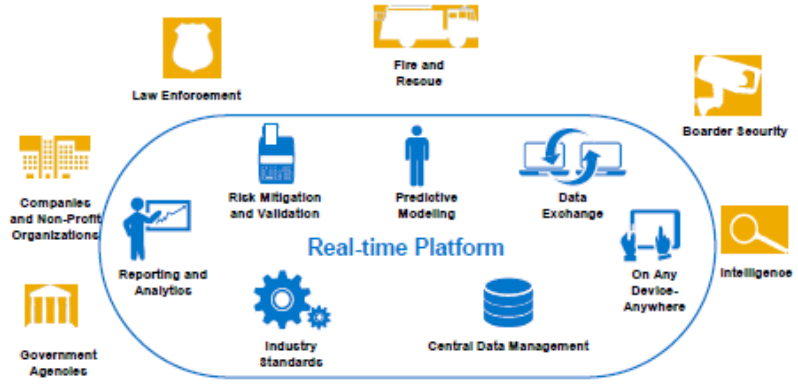
Connected cars – another example

Connected cars have become a reality today. Equipped with sensors that create a 360 degree awareness field, a connected vehicle gathers road hazard data. GIS processes the real-time data and transforms it into useful information. Using live weather data and historical incident data, for instance, GIS can predict the risk of an accident occurring on a specific section of road when it is raining or when fog will make the road hard to see.

GIS also plays an important role in vehicle and infrastructure sensor systems that share real-time data with each other. While drivers are traveling down the road, their vehicles are "talking" with various roadside structures. A geofence around a school and elderly housing can alert a car's system to tell the driver to slow down inside the zone. Car sensors can detect potholes and report the locations to other drivers and the city. Roadside sensor systems can capture real-time data about highway traffic conditions in the lane ahead and automatically relay it to the car's dashboard to forewarn the driver.

While IoT is enabling the driver to stay connected with a central control room through a dashboard all the time, GIS is facilitating quicker solutions in case of a crisis. Imagine your connected car getting stuck in a ditch. You are frantically trying to get out, but without any luck. At this moment, you receive a call, promising

GIS data take the pulse of the smart cities, offering new insights on how the cities are functioning in time.



Real time situational awareness

help to reach your exact location within a few minutes. This is not a miracle, but the power of IoT and GIS integration.

So, what enabled this excellent service?

To start with, the sensors empowered the person sitting in the control room to judge something is wrong as he could see on the dashboard that the wheels of your car are moving but the car itself is stationary. Sensing something is wrong, he calls you and as you confirm your problem, using GIS, he is able to identify your precise location and send help to you quickly. While IoT made him aware of a problem, GIS allowed him to resolve it most efficiently.

GIS enriches navigation systems with additional information during the daily commute to help the driver avoid traffic delays and complete the day's errands most efficiently. By accessing real-time and historical data about the places and times of traffic congestion, GIS helps in determining traffic pattern trends. It can forecast what traffic conditions to expect on a given day, month, or year. This smart routing system help drivers use less fuel and reach places on time.

It won't be long before connected cars will help commuters plan their day. GIS would record the driver's habitual routes by day and week, such as dropping off the dry cleaning, taking the kids to soccer practice, and doing the grocery shopping. Based on this data, GIS predictive modelling would create routes tailored to the driver's routine on a given day.

The more vehicles that connect to a community's data sharing platform, the more efficient the urban transportation system becomes.

A safer world with real-time GIS and IoT

Disaster monitoring can be greatly facilitated by real time sensor based data, and response can be faster through GIS integration. When disasters strike, every second counts. Real-time situational awareness saves lives and helps protect people, property, and critical resources.

For instance, Karnataka that has been experiencing weather related natural hazards consecutively every year since 2001. To mitigate the risks and have better control over the situation, the Karnataka State Natural Disaster Monitoring Centre (KSNDMC) thought of establishing Master Control Facilities, which provide alerts/early warnings/forecast/advisories to the farmers, fishermen, governance and others in the State along with information dissemination for real time data towards providing near real time alerts/ early warning/advisories to the community.

The centre collects the information through state of the art natural hazards monitoring sensors, information and communication system, and uses the ArcGIS platform for locating which areas are going to be affected the most and makes its evacuation plans accordingly. While GPRS enabled and solar powered telemetric rain gauges have been established and made operational at 1638 stations, automatic weather monitoring stations have been installed and made operational at 135 stations. VSAT enabled and solar powered permanent seismic monitoring stations have also been installed and made operational in the State. These initiatives now enable the centre to manage disasters in a much more efficient way, leading to better prevention, response and recovery.

What lies in future?

The world of citizens and consumers is already interconnected digitally—people are connected with each other and with their governments and businesses. Leveraging this vast network of devices and sensors is perhaps the latest trend and the number one priority for organisations that want to remain ahead in terms of having a comprehensive enterprise GIS for the future. Everything from smartphones to crowdsourced social media feeds is being used to integrate real-time data from the IoT directly into a GIS

layer stack, where the data is analysed, visualised, and reintegrated into online applications for use by either professionals within the enterprise or by consumers and citizens.

There remains not an iota of doubt that amalgamation of real-time GIS and IoT is bringing in fantastic results across all sectors. Trucking and logistics companies are using IoT & location intelligence to track packages and make sure deliveries reach customers on time. They're also using tracking data to make their operations more efficient: to save gas, reduce mileage, ensure that their drivers don't exceed their allotted hours for the day, and more. That helps improve the bottom line.

Retail companies are also analysing patterns of life through data that's collected from the apps people opt in to download on their mobile devices. Retailers are now able to understand not just buying behaviours but travel patterns and where people shop. Location analysis helps them decide where to place their stores, where to advertise, and how to market to potential customers more effectively. That, in turn, increases in-store traffic and improves sales.

Real-time health monitoring can be life-saving. Location-based intelligence is critical in healthcare. Insight into 'where' makes all the difference in access to care, quality of care delivered, and the opportunity to achieve a positive healthcare outcome. There are many examples, from simple calculations of travel time to get to a clinic, to more unique uses such as setting up a geo-fence to keep individuals suffering from Alzheimer's disease safe. Newer technologies even make it possible for smart drones to deliver emergency resuscitation equipment to heart attack patients using spatial intelligence technology.

As the IoT and its applications mature, the future will become increasingly intelligent and automated. Machine to-machine communication and machine learning, as well as predictive (what will happen?) and prescriptive (what should be done?) analytics, are already changing the landscape across retail, manufacturing, utilities and government entities. The power of location and IoT has the ability to identify where disruptions are likely to occur and empower organisations to act in advance. In times to come, these technologies will be used to build more powerful, personalised and safer experiences.

The next leap in GIS technology and computing is connecting to the vast network of devices providing data in real time. The more accessible data is, the more important it will be to understand it. And maps are the visual language for understanding the context of data.

In IoT, everything has a place. When external context like weather, traffic and demographics are added to that, we land on a rich source of real time insight. The common factor is location and this makes GIS the essential means to make sense of it all, focus on what matters and take the right action. The combination of data from IoT and spatial analytics from GIS enables taking a prescriptive step toward saving lives and money, rather than simply predicting outcomes. A geospatial ecosystem of shared data makes it easier for utility companies, emergency providers, and anyone else providing community services to understand data, act in real time, and ultimately improve the lives of citizens.

Next-Generation Automobiles by Mobileye

It is estimated that a motorist makes 400 observations, 40 decisions, and one mistake for every two miles driven. The US-based National Safety Council puts this in perspective with its own statistics that says motor vehicle accidents resulted in more than 4.6 million injuries and 40,000 deaths in the US last year. While this can be traced to a variety of factors including distraction, fatigue, aggression and impairment, the fact remains–far too many vehicular accidents occur on the roadways.

With recent advances in sensor technology that have been implemented both roadside and in vehicles there is a belief that real-time alert systems will mitigate traffic collisions by giving drivers a greater awareness of accident potential and sufficient time to take action.

Mobileye's sensor technology uses visual sensors that repeatedly scan and identify common highway features, obstacles, and conditions including lane markings, speed limits, road conditions, weather, pedestrians, accidents, obstructions, and other roadway related information. Distances to these traffic constraints are continually recalculated in real time and potential dangers are conveyed to the driver with visual and audio alerts.

The system employs computer vision, an application of artificial intelligence that extracts cognitive information from digital images and videos that emulates the manner in which humans process and respond to visual information.

The technology deployed includes a number of traffic monitoring capabilities and the resultant safety features including autonomous emergency braking, blind spot monitoring, lane centering, forward collision warning, intelligent speed adaptation, night vision, pedestrian detection, road sign recognition, and other functions. The extensive amount of data collected to support these features is processed on-the-fly using onboard technology that is capable of computing trillions of mathematical calculations per second.

Location plays an important role in the scenario and this is where Esri's ArcGIS plays an important role. The spatial analysis capabilities of Esri's software is being used on the data collected by Mobileye's Shield+ to expand

its functionality and provide cutting edge location intelligence, refined visualisation, and enhanced mapping capabilities. By synthesizing this network of sensors into a common unified map, cities can now have a type of situational awareness that was previously unavailable.

Mobileye's Shield+ streams road safety data retrieved from city fleets into Esri's ArcGIS platform, where information such as pedestrian and cyclist detection in blind spots can be viewed on the Mobileye Smart Mobility Dashboard. Shield+ alerts are updated to the dashboard in real time, providing a city-wide view of pedestrian and cyclist safety.

Amongst other things, this allows users such as municipal bus drivers to receive alerts about imminent hazards seconds before a potential collision, and to have a better, safer awareness of the roads they travel. Integration of Mobileye's sensor technology with ArcGIS provides cities with the ability to visualise and analyse real-time location data from Mobileye's Shield+, improving safety for all road users in urban environments.

In the future, Mobileye is planning to make greater use of artificial intelligence in the autonomous car system it is developing so that the cars using the system can respond more quickly and intelligently in emergency situations and during times of heavy traffic. The technology is intended to go beyond rule-based decision making by analysing and learning from the data it collects and the decisions it makes based on that data, which will allow it to develop more human-like response skills. "Currently, we are developing connected Advance Driver Assistance System (ADAS) systems," says Nisso Moyal, Director of Business Development & Big Data at Mobileye. "What this means is that we will be able to alert drivers not only to a potential collision that has been detected by the onboard camera itself, but also to dangerous conditions that are on the roadway ahead, such as a sharp curve or an accident 500 meters up the road that has been identified by another vehicle equipped with our technology."