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Smart city command and control centre

Leveraging geospatial data

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This whitepaper has been curated by IET's expert volunteers in India from the Smart Cities working group of the IET Future Tech Panel. It sheds light on the role of geospatial data in building smart cities via Integrated Command and Control Center (ICCC) which forms the heart of city operations. It also talks about various use cases and benefits of geospatial data in smart cities.

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Smart city command and control centre leveraging geospatial data

Smart City – Integrated Command & Control Centre

A smart city in today's parlance is a digitised city that in future will transform into an autonomous city leveraging data driven insights. Every city plans to build or has already built or is in the process of building an Integrated Command and Control Center (ICCC) which is at the heart of city operations, acting as the brain.

Many cities have seen benefits of using ICCC for

- Macro situation monitoring and analysis,
- Multi-agency collaboration and operations,
- Crisis management, and
- As a decision support system for city authorities.

ICCC in a smart city is a well-architected and known solution that has the capability to integrate, interact with and control multiple city applications pertaining to traffic, surveillance, transport, emergency applications, smart lighting, smart parking, environment, e-Governance, ERP etc., in one single coherent interface. Interoperability is the key in building such an integrated system and to bring in ease of operations and smooth flow of information across systems and applications it's very essential to have a standardised and well defined interface and data exchange formats.

Must have features of an ICCC solution include:

- Connecting and managing data and events from multiple sources which includes IoT sensors, IT systems, OT business systems and open data sources

- Processing and visualising city data to provide both real-time information and analytical insights using dashboards and reports that can be adapted to the individual needs of each user role

- Correlating and analysing data to extract key informational insights and using this intelligence to inform decision making and automate standard operating procedures

- Measuring and tracking key operational and performance metrics

All the above features should lead to providing 'Outcomes'. Outcomes can be measurable or non-measurable, of which, one can the see impact over time. Such outcomes could attribute to enhance safety,

save costs or generate revenue or increase productivity. For every city, outcomes are critical to create a smart and sustainable city.

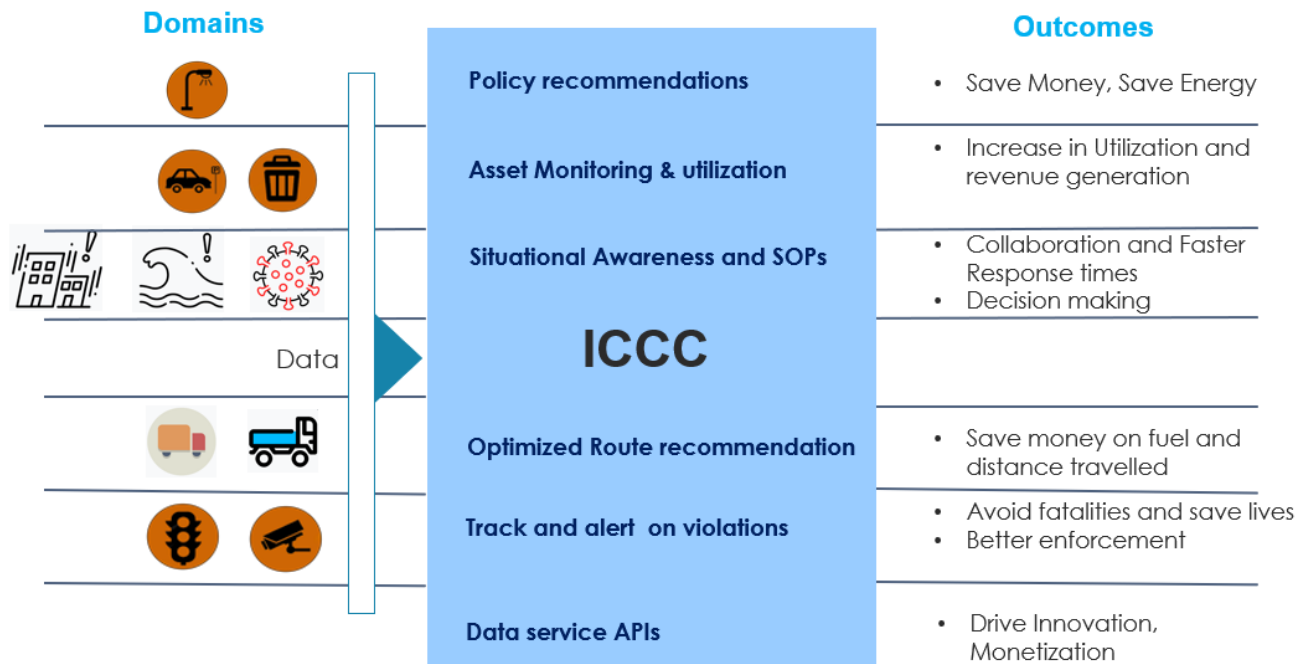Figure 1.0 below identifies indicative outcomes across domains

Figure 1.0

A typical architecture of an ICCC incudes layers such as sensor/device/application, network, integration, data orchestration, application and presentation. While these are necessary from a technical point of view, from a day-to-day perspective, the key layers would be data ingestion layer, event handling or operations layer, business intelligence and recommendations layer.

Along with these layers, every ICCC has a quintessential component which is the Geographic Information System (GIS).

A GIS engine is not just a repository of geo spatial data but a framework that gathers, analyses, and transforms location data from the physical world to the digital world. Every ICCC platform integrates with a GIS map enhancing not only the visualisation experience but also bringing in the true situation awareness.

Benefits of geospatial data in smart cities
Geospatial data plays an instrumental role in many major domains of a smart city namely traffic, transport, surveillance, IoT sensors, e-governance etc.

Geospatial data is available for city applications viz ICCC via a GIS engine. Before data reaches a GIS engine, a thorough survey is conducted physically with automated machines. This data is processed and appropriately transformed into different layers on top of a base map.

Few use cases on how geospatial data is leveraged in smart cities via ICCC platform are as follows:

Traffic

Geospatial layers for traffic and demographic data of people and asset locations, once integrated with ICCC platform, helps to derive insights into the following:

- Identification of traffic congestion hotspots
- Traffic violations (red light violations, wrong direction, wrong parking etc)
- Traffic incidents tracking
- Establishing green corridors in emergency situations

Transport

Geospatial data for transport plays a prominent role in vehicle, fleet management where route optimisation not only saves time but also impacts the costs. Use cases for transport when integrated with ICCC platform include:

- Vehicle tracking (turn-by-turn)
- Public buses tracking to check on-time vs scheduled time
- Fleet route optimisation in domains like solid waste management
- Emergency vehicles tracking and shortest route guidance

Surveillance

In Surveillance, geo-spatial data combined with other data (traffic data, violations data, criminal data etc.) integrated by ICCC platform helps derive following use cases:

- Crime hotspots in a city
- Crime hotspots by category of crime
- Accident hotspots in a city
- Route risk profiling to police based on crime/accident history
- Incident management
- Crowd management
- Large events management by zoning the geo spatial areas

IoT Sensors

Every IoT sensor integrated into an ICCC platform is plotted on a GIS layer indicating its functional status and capability to operate directly from GIS map.

Plotting of sensors in GIS layers also helps to group these sensors for efficient operations.

Most of these domains include:

- Smart lighting
- Smart parking
- Smart bins
- Environment sensors
- Public address systems
- Digital signage
- Emergency call box
- Smart water
- Smart electricity
- Airports
- Ports
- Agriculture

Environment

Environment map of clean air is becoming the priority of many cities. Though Covid lockdowns have made air cleaner, post lockdown the trend shows that pollution is a serious issue. Data from environment sensors plotted on GIS maps along with status of multiple parameters such as AQI, PM10, PM2.5, temperature, humidity etc, plays a key role in helping authorities in the decision making process.

Pollution data is also pushed to variable message displays, citizen mobile applications with a geo-based targeted approach alerting citizens on current environmental conditions.

Geospatial maps also are useful for authorities to make decisions when there are industrial gas leaks, earthquakes, cyclones etc. Plotting the impact area and impact direction on GIS maps helps authorities to evacuate people and save lives.

e-Governance

In e-Governance domains like Property Tax, Water Tax, Building Plan Approval, Birth, Death, Marriage registrations etc., a geo spatial view helps to identify the following use cases

- Property Tax or other Tax Collection trend ward wise
- Identifying encroachments of lands or public spaces
- Identifying locations where more Building Plan Approvals are applied
- A macro view of births, deaths and marriage certificates issued
- Citizen grievances zone, category wise gives a complete view to authorities on where the action is necessary

Urban indicators

Geospatial data along with data from satellites once processed and integrated with ICCC helps in better decision making with these use cases:

- Identifying change in ground water tables over years
- Identifying change in water bodies in a city
- Identifying change in built-up area in a city
- Identifying change in city vegetation index
- Identifying areas that could be flooded faster in case of moderate to heavy rains
- Identifying areas in a city that fall under urban heat islands
- Identifying right spots in cities for establishing a new hospital, school etc.,

Others

Geospatial data in integration with ICCC creates the opportunity to innovate cross domain use cases and solutions.

- Geospatial data helped to plot COVID hotspot zones during the pandemic
- Ambulance movement and availability was tracked to accurate location
- Created impact to citizens by providing location of hospitals with beds availability, fever hospital locations, quarantine centers
- Locations of essential supplies, public distribution systems were effective during lockdown

GIS Data Challenges

While most of the cities are in the process of streamlining GIS data from multiple domains few challenges still exist which calls for the need of a single portal for all GIS data

- Duplication of effort across different departments in GIS data collection and processing
- Data inconsistencies and multiple data schemas are causing integration and correlation issues
- Frequent upgrades are missing leading to not having real time information
- Adherence to geospatial data standards
- Data standardisation across departments is missing
- Open data capabilities
- Accuracy of data

GIS Implementation Challenges

Challenges in data acquisition, standardisation creates multiple implementation and operational challenges. If a city plans to digitise their land records system, unless all involved departments work cohesively sharing data across departments, defining common schema and procedures it would be a mammoth task.

Without a common data format, data sharing procedure, just to get a basic cross-sector view of localised demographic information, one can easily look at dealing with data from minimum 20+ departments having

120+ GIS layers that have to be integrated and processed. Such a gap, if not addressed makes it extremely difficult to get a holistic view of on ground status.

Lack of such processed GIS layers doesn't give city authorities the correct GIS layers to visualise. Especially in emergency situations, lack of such data impacts the decision-making process.

In countries, cities where it snows, GIS data showing the routes cleared by snow ploughs not only informs citizens well in advance but also helps them in better planning. It becomes quite a daunting task when such information is available but not properly plotted or shared on a GIS map

Conclusion

While ICCC solution is the 'engine' of a city, GIS data is the 'fuel' that runs it. Day to day operations of a smart city involves knowing the status of different components in a city. KPI based measurement in city platforms help to identify what is going right and what's not whereas a map view of such data leads the way to actionable insights. Unification of GIS data, standardisation of data formats and interoperability is the key to leverage GIS capabilities and benefits. It's imperative for every city to have a centralised GIS application bringing in data from multiple departments and sources. GIS data liberalisation is beneficial not only to government but also to private enterprises, research organisations, data analysts. Governments should also think about bringing in more open GIS data capabilities in a move to empower governance, sustainable development goals and citizen empowerment.

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