Realizing ‘Smart Cities’ with Technology

A KPIT Perspective

November 2015
Foreword

With 31% of India’s population living in cities and this percentage set to double by 2050 - the need for cities driving continuous economic growth along with environmental sustainability has never been more evident. Growing urbanization is creating pressing need for policymakers to answer on priority the issues relating to increasing emission levels, inadequate public transportation and infrastructure, and overall resource constraints. Through the ambitious ‘Smart Cities mission’ Government of India is looking to induct newer and integrated technologies to address these challenges, and improve the quality of life of citizens. The key elements selected under the mission are Transportation, Energy, Water management, Environment, Smart Governance, Citizen Participation, Digitization, Public safety, Housing, Education and Healthcare.

The Smart Cities mission therefore is an exciting opportunity for technology providers to collaborate with town planners, Urban Local Bodies (ULBs), and consultants in developing a vision toward achieving the Smart Cities, and enable the Government to maximize its technology investments through various models including public-private partnerships.

Many cities around the globe have successfully transformed into a smart city through technology adoption for a connected experience. While the technology blueprint of such cities could be referred to for guidelines and as indicators, the learnings cannot be applied as-is in the Indian context. From demographics to the current status of infrastructure in Indian cities, there are many differences that make each city very unique. Therefore, in the journey toward becoming a ‘smart’, each city will require an exclusive approach, and hence will prefer partners who have deeper understanding of Indian issues and can provide localized solutions using global best practices.

As a technology provider with a global clientele and footprint, KPIT develops and deploys solutions that are tailored to geographic regulations and specifications. This positions us well to bring in best practices from across the world and localize the solutions for India. Our Technology Solutions and System Integration expertise enable Automotive & Transportation Companies/Operators, manufacturers, Government bodies, Energy & Utility companies, and City authorities, to derive enhanced value from their technology decisions and investments.

Through this whitepaper, we present our perspective on the realm of technology solutions that would be required to enable and empower the ‘Smart Cities Mission’ in India.
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Technologies of relevance for Smart cities

Several smart cities globally have already implemented point solutions that have demonstrated the fact that existing hardware/software functioning in silos cannot make a Smart city. Truly becoming a Smart City requires seamlessly interconnected systems that can be retrofitted over the existing infrastructure. Such systems need to offer real time actionable data & analytics for its stakeholders i.e. both the administrators & the citizens in an integrated approach.

It is here that a major confluence of the Smart Cities Mission objectives and our expertise finds a platform. KPIT has tested and proven solutions such as the Intelligent Transportations Systems, City Surveillance & Traffic Management, Hybrid/Electric vehicle retro-fitment technologies, Automatic Meter Reading (AMR), Smart Governance & Citizen participation solutions, Digital campus, Integrated City Command Centre etc., that correspond to the key elements described in the Smart City framework by the Ministry of Urban Development (MoUD). KPIT further brings in the capability to customize the solutions as per a city’s requirement, and integrate these with supporting technologies of Data/Social Analytics, IT Infrastructure Management, IoT, System Integration and Hosting & Cloud Services.

Figure 1 KPIT Solutions for smart cities
Transportation
Urbanization is affecting Indian cities in a big way. India loses 60,000 Crores annually in traffic congestions. Only 8% urban population in India uses public transportation for daily commute, and despite owning only 1% of world's vehicle population, India contributes to 15% of all the accidents globally.

If infrastructure expansion alone is considered as a means to address the challenges, India would need to invest $ 1 Trillion in the next 5 years. However, many smart transportation initiatives in India and globally have established that technology can reduce the need for extensive infrastructure expansion. An Integrated Transport Management System (ITMS) approach with a long term vision is needed in achieving smart transportation goals.

Intelligent Transport Management System (ITMS) – the concept
Intelligent transport management system (ITMS), is the thinking, planning and envisioning of an end to end transportation solution for a city. This includes planning for smart infrastructure for future mobility needs, Multimodal planning, data integration planning & future proofing and ability to provide and integrate Smart Services and solutions addressing various issues like Parking, Real Time Information to citizens, Driver monitoring, Route optimization etc.

Figure 2: The ITMS Framework
1.1 KPIT’s Electric & Hybrid Vehicle Solutions

India is ranked 3rd in terms of CO2 emissions contributing to 5.7% of the world’s emissions. Transport emissions contribute more than 50% of the total emissions in India. The recent WHO report revealed that apart from Delhi, there are 12 other cities in India that rank amongst the top 20 polluted cities in the world. Such alarming trends make it imperative to encourage adoption of hybrid automotive solutions that bridge the transition from a fossil fuel era to a world of electric mobility.

In order to enable this transition, and reduce dependency on fossil fuel imports, the National Electric Mobility Mission Plan (NEMMP) 2020 through its Faster Adoption and Manufacturing of Electric Vehicles (FAME) initiative is promoting hybrid and electric mobility, ensuring a vehicle population of about 6-7 million electric/hybrid vehicles in India by the year 2020.

KPIT with its expertise and know how in powertrain technologies, and on conversion of fossil fuel vehicles into hybrid and electric vehicles, has been working with the National Electric Mobility Mission (NEMM), toward standardization, creation of specifications for charging infrastructure, and battery management.

Under the brand REVOLO, KPIT brings a hybridization solution for buses (public transportation), as well as passenger vehicles (cars and UVs), and three-wheelers, as well as a complete electrification solution for buses. KPIT’s Pure Electric & Electric Hybrid solutions help convert existing vehicles such as buses, taxis/LCVs into electric or hybrid vehicles, resulting in reduced emissions, and significantly reduced fuel consumption.

Benefits:
1. Reduced fuel consumption
2. Reduced emissions
3. Improved driving experience resulting in less fatigue.
4. Reduced maintenance cost arising from improved brake life due to regenerative braking and improved clutch life due lesser gear changes
5. Increase in oil change interval due to less use of engine
6. Reduced downtime cost

Figure 3: Fuel savings and emission reduction with hybrid buses and cars, and electric buses
KPIT Credentials:
- KPIT’s Revolo, is a retrofit solution for vehicles that has been developed indigenously with more than 16 patents to its credit
- Pilot buses developed for MSRTC (Maharashtra), NMMT (Navi Mumbai) and BMTS (Bangalore)
- 15 buses sanctioned for MSRTC and ASRTU
- Significantly cheaper than new hybrid or electric bus. Cost delta of 1.5 Cr – 2 Cr compared to other solutions in the market
- Funding for KPIT’s Revolo available through Union government’s Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) – India Scheme
- REVOLO has won nine international innovation awards for its impact on fuel efficiency enhancement and emission reduction

### 1.2 KPIT’s Intelligent Transportation System

Across the Indian states, State Transport Units (STUs) managing public transportation are looking for technology enabled solutions to enhance ridership.

Current urban bus occupancy in various Indian STUs is <55% and is reducing year on year. This can be attributed to many of the challenges faced by passengers like unavailability of buses on schedule, long waiting time, lack of safety & security measures etc. Decreasing bus ridership is leading to significant economic losses. These losses are further aggravated due to operational inefficiencies.

There is a need for a solution that integrates technology with the public bus transport system, thereby streamlining the STUs operations as well as make public transportation more convenient for commuters. KPIT’s ITS addresses the above concerns by enabling innovative technology in buses thereby helping India to achieve world class urban transportation.

KPIT’s ITS is an integrated hardware and software wireless system designed to track and monitor buses. It consists of a holistic, on-bus intelligent transportation system (OBITS) fitted on buses, and a set of cloud-based ITS command center applications. The OBITS system on buses collects...
the data related to vehicle location, vehicle health, driver behavior, and route. This data is transmitted via GPRS onto a central cloud based server. The command center application uses data analytics to derive intelligence out of this data, and supports functionalities like Passenger Information System (PIS), Automatic Vehicle Locator (AVL), Security camera network system (SCN), Vehicle Health Monitoring and Diagnostics (VHMD), and Emergency response management.

Benefits for the STUs:
For the STUs: The solution supports STU’s in improving vehicle safety & operational efficiency as explained below.
- **Improved profitability:** features such as vehicle health monitoring and driver behavior monitoring ensures higher uptime of the bus. Driver behavior ****
- **Increased Operational Efficiency:** The ITS systems empowers transport operators to track and monitor the bus operations in real-time, enabling them to take timely decisions supported by analytics resulting in better fleet tracking & schedule management. For e.g. If a bus breaks down on the road, operators are alerted and incident management process is initiated immediately resulting in a new vehicle deployed to complete the trip.
- **Increase in Ridership:** The ITS systems improves travel experience of the commuters due to real-time passenger information availability and enhanced safety measures.

Benefits for the passengers
- **Passenger Convenience:** real-time information is available to passengers for planning their trip. (Accurate Passenger Information System, Smart Phone Integration, Mobile Application for Travel & Route Planning, Integrated eTicketing system). For e.g. Multimodal Passenger Apps
- **Safety & Security:** Surveillance cameras installed inside the bus capture images of the bus which can be sent to the command center in case of a panic situation, thereby allowing the authorities to gauge the nature and magnitude of emergency and take action accordingly.
- **Better driving:** Vehicle health parameters and driver behavior are monitored remotely. The driver can then be communicated appropriately or training needs can be identified to enforce good driving practices. This will ensure safety of vehicle and passengers.
KPIT Credentials:
- 4000+ ITS installations - KPIT is the largest Transportation Technology company to provide Device + System Integration + Backend IT operations + On Ground Support
- 19 City and States using KPIT’s UBS-II ITS – including CSTC (Kolkata), APSRTC (Hyderabad), PTC (Puduchery), NMMT (New Mumbai), TMT (Thane), SMT (Solapur), HRTC (Himachal Pradesh), KSRTC (Kerala), ASTC (Assam), MBMT (Mira-Bhayander), KDMT (Goa)
- Largest Market player: KPIT is the largest supplier of UBS-II ITS systems with more than 90% market share for more than 1 year now.
- National Level ITS Architecture & Standardization – KPIT has contributed in making recommendations and defining the National level ITS architecture & standardization guidelines to institutes like BIS & ASRTU
- Service Network: KPIT provides on ground support to STUs that implement UBS-II ITS across the country
- Emergency response implementation for the National Highways Authority of India (NHAI) including patrol vans, ambulances and toll trucks.

1.3 KPIT’s solution for Driver Behavior & Vehicle Health Monitoring
Passenger safety is a major concern in public transportation considering the large fleet volume and the number of passengers carried. From ensuring women safety to avoiding accidents due to negligence, and vehicle health problems, safety has to be ensured across several aspects. In a recent study by Embarq, 55% of all road accidents are because of driver negligence, making it imperative to monitor driver behavior, in order to take corrective actions, in form of alerts, training in case of repeat offence etc.

The Urban Bus Specifications II (UBS-II), have made it mandatory for bus OEMs to open up over 90 vehicle parameters related to Vehicle Engine, Transmission, and Safety system for monitoring and analytics. Monitoring of these parameters using KPIT’s remote vehicle health monitoring solution can help STUs bring down their overall maintenance costs and improve operational efficiencies. The solution provides real time information on 90+ key performance parameters of Engine, Transmission & Electrical System to the integrated command center for remote monitoring & diagnostics. This enables better maintenance schedule management thus
reducing the maintenance costs for the STUs. In addition to this, the solution generates a Driver scorecard helping in reporting case of over speeding, harsh acceleration, harsh braking etc. This scorecard can be used by the management for driver training purposes and driver performance appraisals.

Benefits:
- Enhanced Passenger Safety: By monitoring driver parameters like over speeding, harsh acceleration and deceleration, operators at the command center can take corrective actions to prevent accidents
- Lowered bus wear and tear: By ensuring good driving habits, the wear and tear of bus parts like tires, clutch, brake pedals etc. can be reduced. Spare parts contribute to 60% of operational costs for STUs
- Reduced Bus Breakdowns: By monitoring bus parameters, it is possible to predict component failure and provide preventive maintenance.

1.4 KPIT’s Emergency Response Solution
Accident Victim Survival rate in Indian cities is around 6% -10% compared to world’s best survival rate of 45% in USA. This is due to the lack of real-time communication with the relevant agencies such as ambulance, and fire brigade. This highlights the need for an emergency response system to be implemented in Indian cities.

KPIT’s solution consists of a system with panic switches and cameras on vehicles. The solution can be programmed such that, in case of emergencies, information can be transmitted to a command center in the form of an alert, and camera images can be streamed in real-time to the command center in order to gauge the criticality of the situation. Based on these alerts and images the Command center will be able to inform the depot manager about location of the

Figure 5: Vehicle & Driver Monitoring Solution
vehicle as well as monitor the location of the closest emergency response vehicles (like Ambulance, Police & Fire Brigade). The command center operator can inform the nearest traffic police to facilitate green passage for the deployed emergency response vehicles helping them to reach the emergency spot in the shortest time possible.

![Image: KPIT's Emergency Response Solution](image)

**Benefits**
- **Reduced Emergency Response Time**: On identifying an emergency on road, the nearest emergency vehicle can be evoked to provide road side assistance. Response actions are automatically triggered rather than current manual actions, reducing the emergency response time.

**KPIT Credentials**
- Emergency response implementation for the National Highways Authority of India (NHAI) including patrol vans, ambulances and toll trucks.

**1.5 KPIT’s solution for Passenger Information System**

Many citizens find public transportation inconvenient because of lack of first and last mile connectivity. Planning a trip also becomes difficult due to the lack of real-time information. Providing real-time accurate information to passengers will help in making public transportation the preferred mode of citizen commute thereby improving overall ridership.

KPIT’s solution consists of Estimated Time of Arrival (ETA) algorithms that have been developed specifically for the Indian context. The solution is implemented in form of real time bus schedule displayed on LED/LCDs at bus stops/ terminals and smart phone applications.
This solution provides passengers real-time bus location and expected time of arrivals and departures, helping them in dynamic decision making related to their travel plans.

Benefits:
- Passenger Convenience: The app allows complete trip planning for passengers, and provides an interface for the passenger’s family to keep a track of their family members. Commuters will be able to have a delightful travel experience as they can plan their journey better with accurate PIS & interactive mobile application. This will in-turn help to increase the number of commuters, thus increasing the revenue generated by STUs.

KPIT Credentials
- Passenger App for Inter City MSRTC buses plying between Mumbai and Pune.

1.6 KPIT’s solution for Traffic Monitoring and Control
India loses INR 60,000 Crore due to traffic congestion, (including fuel wastage), slow speed of freight vehicles and waiting time at toll plazas and checking points, a study on operational efficiencies of freight transportation by roads has claimed. It said vehicles crawl at an average
speed of less than 20kmph on some key corridors such as Mumbai-Chennai, Delhi-Chennai and Delhi-Mumbai stretch. Additionally, because of lack of green corridor planning, traffic departments in cities find it difficult to navigate traffic in emergencies.

KPIT’s solution is a holistic Traffic Monitoring & Control system comprising of Traffic Prediction Algorithms, Vehicle Tracking Application, CCTV Surveillance Management System and a Traffic Management Mobile App for Public. The solution can process historical as well as real-time traffic volume data for operating traffic signals and sign-boards dynamically. It can further track the traffic violators using Automatic number plate recognition using image processing algorithm.

**Benefits:**
- 20% reduction in congestions – By controlling the signal timing based on the traffic volume
- 40% reduction in stops for vehicles – By providing more green signals to the vehicles to avoid congestion
- 12% reduction in fuel consumption – By reducing the idle time at intersections waiting for the signal
- 7% reduction in emissions - By reducing the idle time at intersections waiting for the signal

**KPIT Credentials**
KPIT’s partners in this space have deployed solutions for traffic monitoring and control in 140+ countries and 24000+ intersections, with reduced need for cabling.
Utilities

A key tenet of a smart city and better living is uninterrupted power supply. Integration supply and accurate billing will lead to satisfied end-consumers as well as increased revenue generation for utility companies.

India is the fifth largest producer and consumer of electricity in the world with the demand expected to increase from 900 billion kilowatt-hours (kWh) to 1,400 billion kWh by March 2017. Yet, it continues to remain in a state of perennial energy shortage, that predominantly results from Aggregate Technical and Commercial (AT&C) losses. For e.g. in 2013, the total AT&C losses were approximately 27% of the total power generation.

The current challenges can be addressed using newer and smarter technologies starting with the automated meter reading (AMR), to enable accurate and real time billing information from energy meters. Currently, the meter readings are procured manually, this method is inefficient and prone to errors. It is thus that Utilities are adopting Smart meters and AMR solutions.

1.7 KPIT’s Automatic Meter Reading (AMR) solution:

Major components of KPIT’s solution are Radio Frequency (RF) Module, Gateway, Data Concentrator Unit (DCU) and Meter Data Management System (MDMS) on Server. The DCU acquires meter readings from RF enabled smart meters and communicates this information to the server on real-time basis.

The MDMS stores the data received from DCUs to make data available to the billing system as required. Availability of real-time data can help utility companies conduct predictive analysis to manage their energy requirements optimally.

Figure 9. KPIT’s Automatic Meter Reading (AMR) solution
**Benefits**
Smart cities mission requires End to end smart utilities solutions with configurable hardware and upgradable software to match the needs of both the citizens and government bodies, and AMR enables this.

**KPIT Credentials**
Running Phase 1 implementation for automated meter reading (AMR) initiative for one of the largest state electric utilities in India.
Citizen Connect & Safety

According to the National Crime Records Bureau of India report on mega cities that includes top 53 cities with population more than 1 million, the average rate of crime in urban agglomeration centers is 345.9 (Crime Incidence per lakh population). This is 60% higher than the national average crime rate of 215.5 (Crime Incidence per lakh population). Lack of Integrated data intelligence from multiple public sources, delay in availability of emergency help during accidents or crimes and lack of city monitoring for public safety are some of the challenges that have made public safety one of the most sensitive agendas for the government.

1.8 KPIT’s solutions for Citizen Connect & Safety

KPIT’s City Surveillance & integrated command center solution consists of an Integrated Command center with real-time vehicle monitoring command dashboards, that provide actionable views into the daily operations of a city and its citizens. This enables city stakeholders to monitor public areas, analyze patterns, track incidents as well as suspects thereby enabling quicker response.

**Benefits:**

- Seamless multi-source data integration at a centralized command center
- Enablement of emergency alerts through integrated multi agency collaboration
- Camera based citizen monitoring algorithm for event detection

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**The way forward for technology planning for sustainable public safety**

- Improving public safety by integrating data intelligence (on security, weather, criminal records, video analytics)
- Providing immediate visibility aiding in emergency situations during accidents or crimes
- Providing smart visibility-control on people & resources for an effective response & recovery during incidents
- Help in curbing the rising road accidents by offering unique Camera Based Traffic Signal mgmt. solutions
- Enable handling disaster management and critical agendas related to citizen safety
1.9 KPIT’s solution for Smart Campus; Citizen Connect & Participation

As the need of smart and connected communities in India has been identified as part of the Smart Cities Mission, cities need to implement such technologies that provide access to the citizens over a pervasive public Wi-Fi network at affordable costs. Such technologies with intelligent networks could enable digitally empowered citizens through the availability of government services in real time, through online and on mobile platforms.

KPIT smart campus solution enables digitization and citizen participation through Contextual & Location based technologies for efficient city-level governance. These solutions are custom built point apps to perform tasks based on location and context feeds, and can also be integrate based on specific application areas to calibrate functionalities.

**Benefits:**
- Location-based campus navigation solutions for digital, connected & smart campuses.
- Grievance management system (GMS) using QR code based Scan & Post smart solutions
- Location/ Context based reporting to address maintenance issues for public places
- Citizen sentiment, participation and feedback monitoring to empower decision makers and stakeholders with the latest information.

![Figure 11: Solutions for Smart Campus, Citizen Connect & Participation](image1.png)

![Figure 12: KPIT's prototype dashboard developed for a municipal corporation in India for monitoring Citizen Sentiment & Feedback](image2.png)
Rapid urbanization, increasing pollution levels in cities, increased need for citizen safety and the inherent need for making a city more livable makes the proposition of creating Smart cities compelling and need of the hour.

Technology can be an enabler in addressing these challenges and providing solutions. With expertise in systems integration, technology development & implementation, KPIT is well positioned to partner with the city planners, Urban Local Bodies, and civic authorities, to provide solutions that help make it a reality.
About KPIT Technologies
Headquartered in India, KPIT is a Global Technology Company providing Solutions and System Integration expertise to Automotive & Transportation Companies/Operators, manufacturers, Government bodies, Energy & Utility companies and City authorities.

With revenues of over INR 3,000 Crores (FY15), KPIT is one of the fastest growing technology companies in India. Combining its consulting, engineering, and information technology experience and capabilities, KPIT has developed robust solutions to make Indian cities cleaner, safer & smarter and operations of city/transport/utility authorities more efficient.

KPIT has emerged as a preferred partner to numerous Indian Central/state level government engagements, with its ability to localize global best practices and solutions for the Indian socio-economic-technology context.

1.10 Innovation at KPIT
Leveraging our technology and domain expertise, we partner with customers to co-create transformational value that provides sustainable competitive advantage to their businesses. KPIT’s 60+ Patents, majorly in the areas of Hybrid Technology (16), Battery Management Systems (3), Alternate Fuel technology (2), and in fields of Embedded, VLSI, and Energy are a mark of the spirit of innovation.

Every year, approximately 6% of the company revenues are invested in R&D. The DNA for Innovation, the passion to deliver excellence and strong customer focus are drivers of growth at KPIT that make us clearly stand out against competition.

KPIT’s R&D center called ‘Center for Research in Engineering Sciences and Technology (CREST)’ is approved by Department of Scientific and Industrial Research (DSIR) and Department of Science and Technology (DST) as a recognized R&D center.

1.11 Industry Consortiums & Standardization
With a vision to integrate smart technologies in an integrated approach, KPIT has established relevant partnerships within Industry ecosystem to deliver a holistic solution. We are a recognized member of various Industry consortiums including the Technology Advisory Group on Electric mobility (TAG-EM). We have been acclaimed for our efforts and contribution to TED 28, a committee under BIS for Intelligent Transport Systems (ITS) Standardization.

KPIT is the 1st company in India to achieve SPICE Level 3 (Nov –2004), and amongst the top 2 companies in the world to achieve Auto SPICE Level 5 (Dec-2007).
KPIT is also an active member of FICCI’s Urban Infrastructure & Smart City Committee on Smart Cities, whose key objective is to work with the Government to create an enabling framework for the private sector to partner with Government bodies in developing the Smart Cities. This body also acts as an advisory group to the Government about policies and contracts that need to be formulated for various areas in accomplishing the objectives of developing smart cities, and performs a key role in conducting activities that bring states and center together to ideate and review the progress of the states.

For more information please visit www.kpit.com

Figure 15  KPIT’s has relevant partnerships within Industry ecosystem to deliver a holistic solution

“KPIT’s Intelligent Transportation System received a special mention at ‘The European IDTechEx Energy Harvesting and IoT Awards’, 2015.”