



ROLTA

INSIGHTS. INNOVATION. IMPACT

Smart & Safe Cities: Concept to Reality

A comprehensive solution approach



Issue 4

- 3 Welcome
- 4 What are Smart Cities?
- 5 What are the Challenges?
- 6 How are the Cities Categorized?
- 7 What is the Ideal ICT Model for a Smart City?
- 12 Rolta's Recommended Solution/Application Framework for Smart City
- 27 Conclusion
- 28 Rolta SmartCity Solutions
- 30 Innovation Insight: Smart City Aligns Technology Innovation and Citizen Inclusion

Featuring research from

Gartner

Welcome

In this newsletter, we focus on smart & safe city solutions. More specifically, we explore the comprehensive solution approach to fulfill the demands of sustainable needs following the massive upscale of urbanization.

While there are many definitions of a smart city, the underlying theme is to make the cities sustainable across the landscape – Urban Planning & Development, Governance & Citizen Services, Security, Utilities, Water & Sanitation, Transportation, Healthcare, Education, Environment, etc. Various stakeholders play different roles in making cities smart & safe. Technology plays a vital role in both creating new (smart & safe) cities as well as retrofitting existing cities. The phases of plan, prepare, build, manage and optimize smart & safe cities involve the key roles of policy makers, planners, domain consultants, infrastructure & core engineering system providers, ICT infrastructure providers, ICT solution providers and finally the ecosystem for managing and optimizing the services. At a broader level, these solutions should internally build efficiency and integration between systems. Secondly, they should also provide citizens with a user-friendly engagement to internal policies and processes. Additionally, technology solutions need to cater to the scale as well as real-world constraints.

Smart City solutions need a strong foundation. This comes from a convergence of

- 1) Instrumented data - event capture and filtering for timely response
- 2) Systems interconnected to form a larger system - any to any linkage of people, processes and systems
- 3) Intelligent insights - Deep discovery, analysis and recommendations.

The nexus of technologies are maturing at an even faster pace following the complex needs of scalable solutions for smart cities. These include IoT, GIS, Big Data and Analytics, Mobility, Collaboration, Security, Cloud, Software Defined Networks and Core Engineering Systems. The needs of a smart city stretch these technologies to address, not just the technical solution but also the economy of scale, in order to bring multi-fold value.

Rolta, through its unique combination of three decades of Engineering, Geospatial, ICT and Analytics expertise, has proven as a strong leader in providing IP driven solutions for smart & safe cities across the world. Rolta's solutions bring the technology convergence of the four key pillars GIS, IoT/Data, ICT and Analytics through its 100+ pre-built, rapidly deployable smart & safe city solutions covering a wide gamut of areas and available on both cloud and on-premises deployment.

Rolta has played a vital role in several smart & safe city initiatives across the world. Rolta's innovative solutions have been deployed in smart cities globally and have won many accolades for the value they have brought in, both on significant improvements in the internal efficiency of the urban development and governance systems as well as external efficiency of services bringing citizen friendliness and transparency.

I am confident that the research and case studies in this document will help in understanding the comprehensive approach of smart & safe city solutions that are the key focus and thrust areas across the world.

Thank You,

Rajesh Ramachandran

Chief Technology Officer & President,
Global Products & Technology Solutions, Rolta

1st September 2015

What are Smart Cities?

Urbanization is a global and a natural phenomenon. Urban areas are metamorphosing, becoming nerve centers offering better economic opportunities and quality of life as compared to rural areas. Cities across the world have witnessed a trend of exponential population growth as more and more people move to cities in pursuit of better prospects. This also translates into multiple challenges for city planners as they need to plan and upgrade the city infrastructure in proportion with the population influx to meet the rising demands.

The concept of smart city is not new. Today, this term has multiple definitions, varying with each person's perspective.

Though, there are variations in the definition of smart cities, the common key goals for smart cities are: infrastructure, economic sustainability, quality of life, clean & green environment, safety and security of its citizens.

The concept of smart cities can be visualized of as having two facets viz. internal and external.

Internally, smart cities aim at:

- Building efficiency by achieving seamless integration between ICT systems governing critical departments of a city like governance, sewage & waste management, transportation, safety and security and others

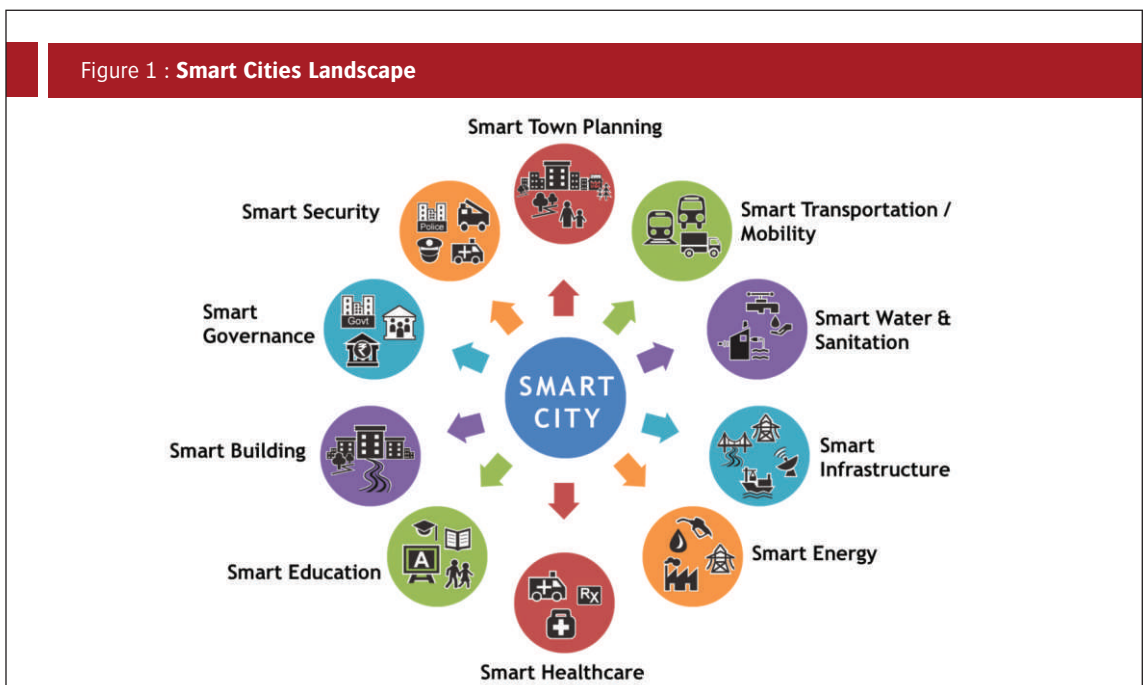
- Creating job opportunities for sustaining the economy
- Infrastructure for accommodating the population influx and growth

Externally, smart cities thrive to:

- Build ability for citizens to engage the city through services
- Provide transparency to internal policies and processes
- Better facilities for higher quality of life

Cities across the globe face unique scenarios and have different priorities. Emerging economies like India have witnessed a rapid of urbanization as a result of paradigm shift from being agrarian to becoming industrialized in last few decades. For example, There exists a plethora of "sub" metropolitan cities along with metropolitan and megapolitan cities like Mumbai and Delhi. It is therefore natural to perceive a blueprint for smart cities in such economies to be primarily retrofitting or brown field with focus shifting to white field and green field cities much later.

Some of the constituents of a typical smart city landscape are depicted below. Infrastructure Communications Technology (ICT) plays vital role in enabling each of these constituent programs.



What are the Challenges?

Every city has a different and distinct DNA. Key challenges depend on outlook and DNA of the city. In general, cities can be divided into three types based on their DNA and unique challenges faced by each type:

- **Investment Driven:** These cities have challenges in terms of rolling out the technologies and services which will generate income and deliver significant ROI
- **Clean and Green Technology Driven:** These cities face challenges in creating infrastructure and services which promote less fuel consumption, are environment friendly and using technologies that reduce carbon footprint
- **Perception Driven:** These cities want to be perceived by the rest of the world as modern and face bureaucratic challenges along with lack of vision and lack of direction

Apart from the above unique challenges, the common ones faced by most cities for their smart initiatives are:

- **Acceptance by the Society:** The success of endeavors taken by a city to transform itself into a smart city depends primarily on how actively its citizens, society, entrepreneurs and visitors are willing to get involved in bringing changes and accepting the implementation of new technologies
- **Prioritizing and Aligning Vision:** City projects often involve large number of stake holders and citizens who are the end users. The challenge is to prioritize needs and align with the vision of governing bodies
- **Funding:** Government finances are mostly stretched. As such, they have little or no budget for funding new and modernizing city projects

These challenges are evident and relevant to cities in developed as well as emerging economies. At the same time, there are some unique challenges faced by cities in emerging economies:

- **Physical Infrastructure:** Cities in emerging economies tend to be densely populated and thus they exert an enormous strain on the limited infrastructure
- **Execution of Plans:** Lack of transparency and limited efficiency of the government in executing projects poses challenges for proper and timely execution of the project plans

How are the Cities Categorized?

Gartner notes in “Innovation Insights: Smart City Aligns Technology Innovation and Citizen Inclusion” that “The development of a smart city master plan that will guide deployment of technology and solutions depends on a combination of elements, business models and decision-making frameworks”. For planning purposes, cities can be categorized broadly into three classes:

Brown Field: These are existing cities with a sizable urbanization. These require a transformation plan for converting them into a smart cities. For example, most cities in emerging economies like India, are Brownfield. The advantage with this category is that the existing infrastructure can be leveraged. There already exists some level of economic sustenance which only needs a timely boost. Societal buy-in is easy.

White Field: These are the areas/cities in vicinity of existing cities. As with the brownfield cities, one can leverage the existing infrastructure. Additionally plans can be charted out for achieving sustenance and for integrated use of underutilized land. There is scope for creating acute clusters for developing economic activities.

Green Field: Formation of new cities. These can be properly planned from day one by implementing lessons learnt from past mistakes as well as learnings from models across the globe. The biggest advantage is that ICT infrastructure can be integrated from the design stage.

Key roles in making smart cities

Several stakeholders contribute to and are influencers of smart cities.

Policy Makers: It is advisable to select policy makers from wide range of society right from academics, civil servants, private to public officials along with representatives from various sectors. This will ensure that the policies made are more pragmatic and inclusive and will also ensure that the societal buy-in is upfront when implementing key policies for smart cities.

Planners: The smart city planner has to plan for uniform development of the area suitable for urbanization, as well as map the environment and ecological areas across the region for coherent development of the smart city.

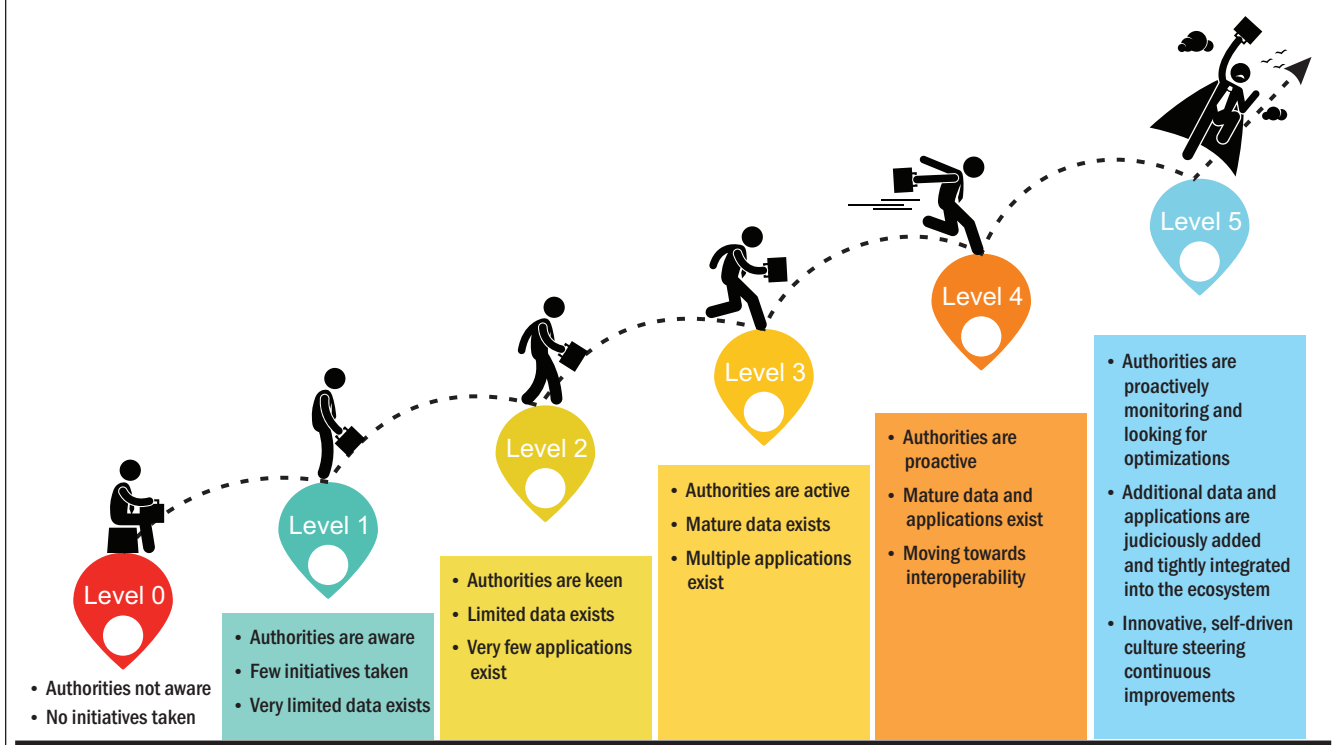
Physical Infrastructure Providers:

Infrastructure has to be in tandem with the policies and plans prepared for the smart cities. These include providers who build roads, buildings, power station and even lay fiber network for better connectivity.

Solution Providers: With policies, plans and infrastructure in place, solutions that effectively build, operate and manage the smart city are required. The key role for these providers is to create solutions to improve the efficiency and effectively deliver the services to the citizens.

As with any other live environment, involvement of these stakeholders is not just one time. They incrementally contribute to the growth and development in iterative cycles. For example, implemented infrastructure and solutions need to make the next cycle simpler for the policy makers and planners, by giving them necessary feedback from previous projects and offering automation and tools for their next phase.

Figure 2 : Smart Cities – Levels of Maturity



What is the Ideal ICT Model for a Smart City?

Though there is no perfect recipe for creating a smart city's ICT, the general principles and key to succeeding in creating smart city is to plan, prepare and execute in such a way that the outcome of the approach are socially unbiased and acceptable, economically viable and environmentally sustainable.

Plan: A proper plan should identify and relate to city's DNA. The plans have to differ based on the type of smart city category, for example: A plan for brownfield city would be focusing more on leveraging the existing infrastructure as against creating new infrastructure whereas the plan for a whitefield city would be concentrating on creating new centers for economic activity.

The plan should also clearly define short term, midterm and long term goals and set strategic objectives accordingly. It should also define the SLA and systems to be placed for monitoring the progress.

Prepare: Preparation for building smart cities is as important as planning. Each aspect merits

careful attention. For example, in the city's ICT infrastructure, critical areas for preparation include procuring data sources and building a viable model. Involvement of transparent governance is also critical in the preparation stage to put in place regulations, proper policies and monitoring systems.

Build & Manage: Build integrated intelligent enterprise platforms, system development and effectively manage the projects on the ICT front.

Optimize: As with any other initiative, it is important to continually monitor performance, identify areas of improvement, shortlist and evaluate technology advancements and systematically implement and integrate the same in the smart city framework.

Technology Convergence

Data, analytics and ICT infrastructure play quintessential role in defining solutions that ensure sustenance of smart cities. The interplay of these elements is crucial for successful implementation of solutions for smart cities.

Big Data: Smart Cities use various types of automations leveraging Information Technology as well as Operational Technology systems. These include sensors, SCADA, DCS as well as Portals and other backend systems. Big data provides exceptional insights when cross correlated with data from heterogeneous systems. However, big data alone will not be of any use unless it is accessible by right people in the correct context and acted upon in the right timeframe.

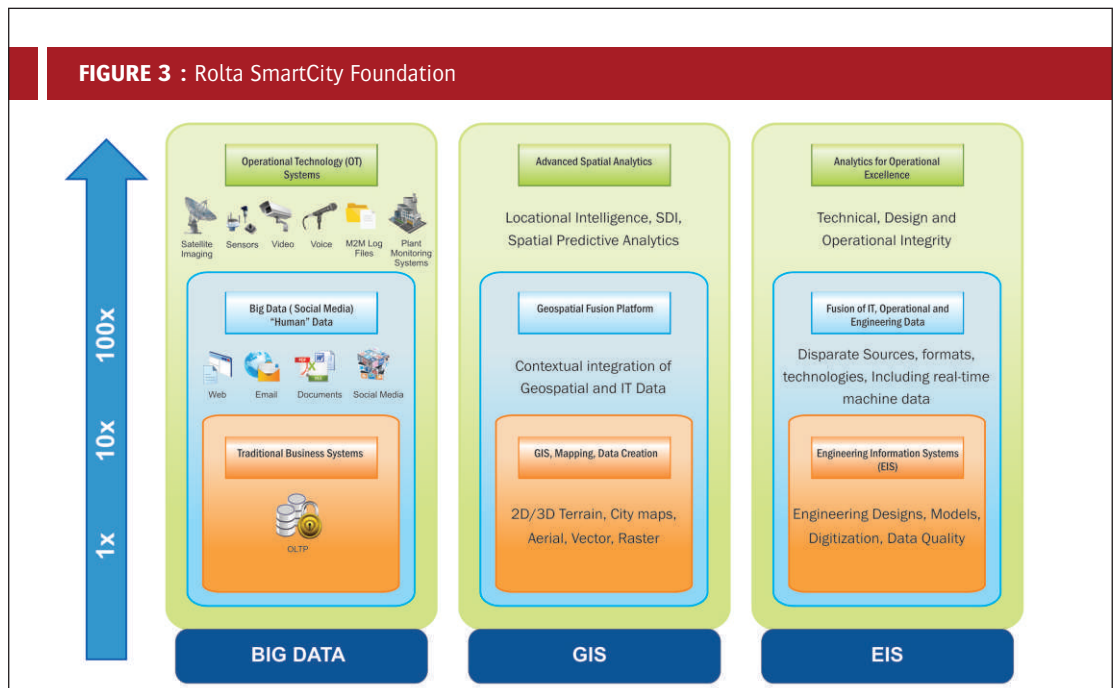
GIS Data: GIS data is the backbone for smart city solutions as modern city management is driven through maps and geographic data. It is also a well-known fact that 80% of available data is spatial in nature. Hence smart cities solutions need to necessarily factor in GIS capabilities.

ICT Infrastructure: ICT infrastructure should be designed to be scalable and flexible to accommodate new business systems, so that it can handle the increased influx of the increasing data generated due to the expanding scope of systems of a growing city.

The interplay amongst these elements is crucial for:

- Real time contextual integration of heterogeneous systems
- Spatial enablement
- Intuitive actionable insights
- Business intelligence and real time, predictive and prescriptive analytics
- Seamless and secure access to data
- Scalable ICT

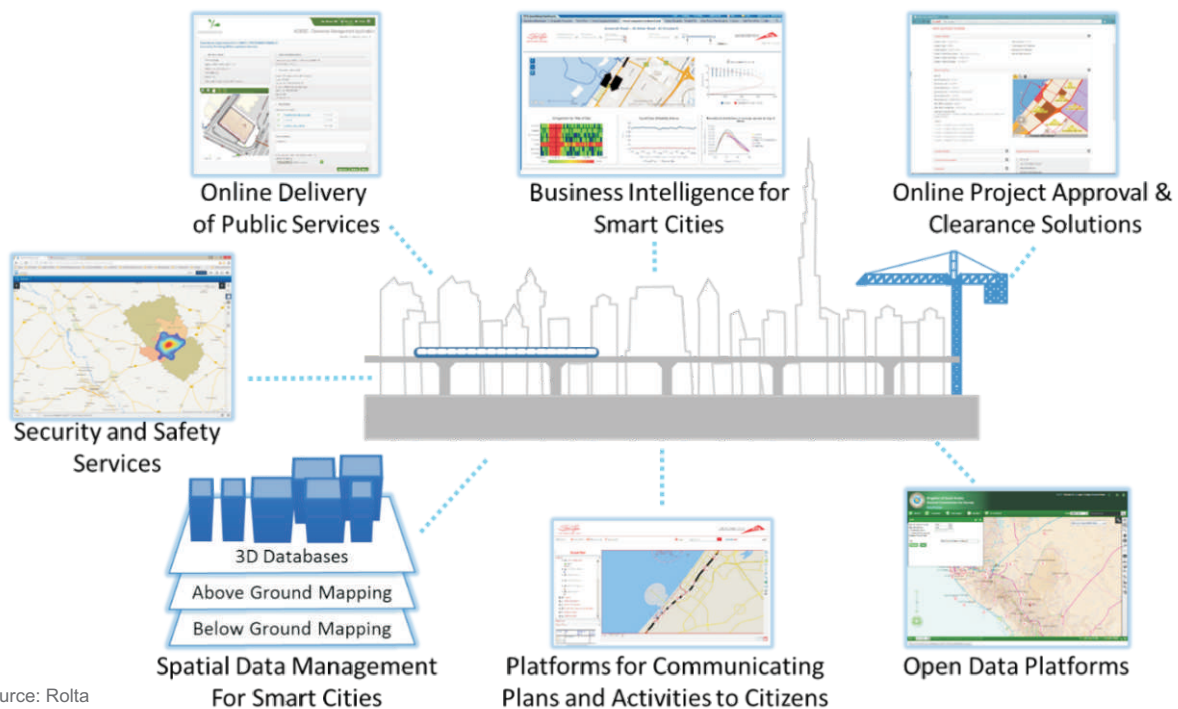
Successful integration of IT–OT systems is essential for all the aforementioned key components to create a meaningful impact. This integration framework should be scalable to allow future changes in the technologies. Facilitating Internet of Things (IoT) and Machine to Machine (M2M) communication to enable a smart operating environment in the right context is one critical aspect of developing a smart city. Other aspect is to go beyond the IoT and M2M communication and focus on augmenting decision making process which impacts the city.



Analytics: In order to improvise and optimize the operations of the city, stakeholders will need to consciously and continuously learn from increasing volumes of data generated by deployed systems. These learnings help in identifying gaps and adapting to changes brought around by incorporation of new technologies and hence the criticality of analytics.

The decision making process varies from the scale of the phenomena; right from emergency situations which may require microsecond event reporting (IoT and M2M facilitate this) to long term impacts such as how will the city achieve smart growth? Where to build a high rise and how will that effect the traffic conditions? It is imperative that the smart city implementers will

FIGURE 4 : Key Systems for Smart Cities



need to have a 360 degree outreach, i.e. not only provide physical infrastructure but also to provide soft infrastructure, knowhow and technologies which will make city functions intelligent and increase situational awareness.

Key framework systems

Several key systems play crucial role in building smart cities. These systems need to be KPI driven to help monitor progress and check their effectiveness. A few key systems which play critical roles in smart cities are listed and described below:

- Spatial data management systems
- Open data platforms
- IT and OT integration systems
- Business Intelligence systems
- Safety and security systems
- Online delivery of public services
- Online project approval and clearance systems
- Platforms for communicating plans and activities

Spatial Data Management Systems: Spatial data collection and management services lay the foundation for smart city as they help urban planners in designing and planning for:

- City planning
- Emergency response planning
- Critical asset surveillance and protection
- Disaster management
- Natural resource management
- Asset management

The spatial data collection and management systems provide context to other systems.

Open Data Platforms: Once the data collection and management services are in place, it becomes important to share the data for usage across city departments. Data standards need to be followed to ensure data captured by a department is readily available to and interoperable with other departments. The data sharing platform needs to be open, standards based, interoperable and easily accessible. Data platforms at various hierarchies of governance like state and national level spatial data infrastructure assume important role. Governments, policy makers and local governing bodies need to consider these and start implementing solutions and standards for creating successful smart city solutions.

IT and OT Integration Systems: The physical infrastructure of cities requires sensors and other physical controlling systems for operations and monitoring activities. Early generations of equipment for controlling systems were mechanical or electromechanical and were a physical part of the equipment. With rapid evolution of operational technologies and information technologies, the newer generations of controlling systems have witnessed the convergence of complex electronic and software systems. Thus it is important to securely deploy and manage OT devices and technologies in integrated continuum with IT management policies, processes, and methodologies across the industry and organizational value chains. It has also become the need of the hour to integrate these technologies with spatial and engineering systems for effective smart city implementation. The benefits of IoT integration are:

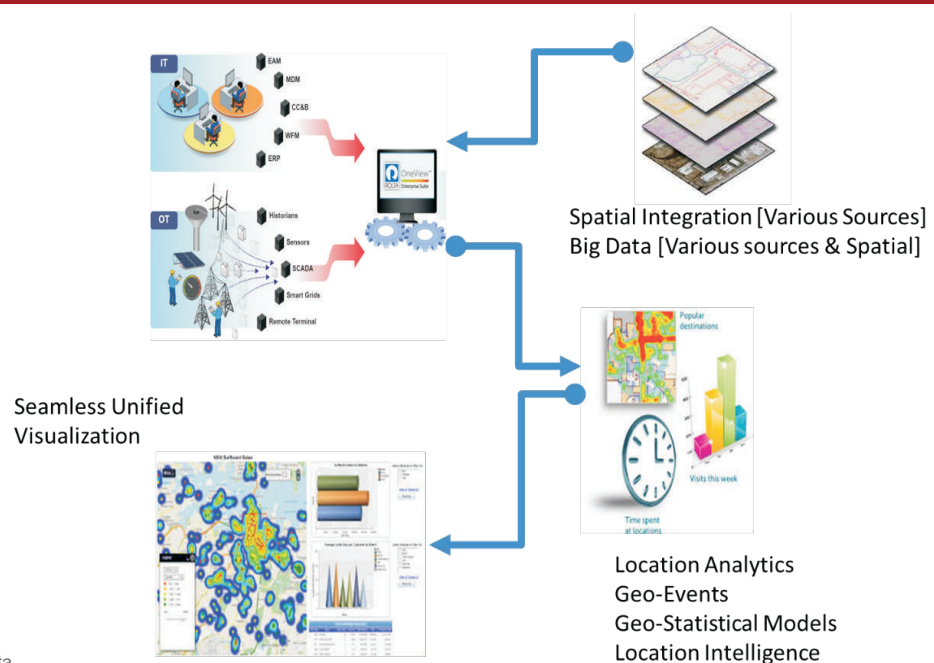
- Improve performance and operations with optimized business processes
- Better align operational areas with overall business goals
- Increase regulatory and environmental reporting and compliance
- Reduce costs from efficiency gains and optimization of operational processes, asset maintenance, and field workforce management

- Avoid unwanted incidents in the operational areas and improve operational excellence
- Better decisions, lower risks and shortened project timelines

Business Intelligence Systems: To gain insights on the operational data gathered from the integrated IoT systems, decision makers need to have data available on hand and at a centralized location for correlative study. This becomes possible by implementing Business Intelligence and data mining systems which can unearth required information from the big data collected by these IoT systems. The Integration of BI systems with GIS systems and other engineering systems enable creation of spatial dashboards and scenario analytics. These dashboards can be viewed by the executives and decision makers to monitor the KPI's, run scenarios and know the status of each project. The benefits envisioned are:

- Bring data into a unified warehouse so it can be analyzed for decision making
- Provide easy to access tools for assessing performance of different operational areas across geographies and different times
- Understand impact of policy interventions on projects in due time
- Make data and tools accessible to all levels of government and decision making

FIGURE 5 : IoT Integration



Source: Rolta

Safety and Security Systems: Communities are increasingly exposed to industrial hazards, incidents of crime, and proximity to natural risks such as wildfires, earthquakes, flooding, and severe weather conditions. Increased exposure implies that the emergency response requests are more frequent, complex, and dangerous. These demands for public safety require sophisticated computerized systems to manage the volume of information needed for a safe and effective response by our law enforcement agencies, medical agencies and first responders. In order to ensure safety of the crew, the citizens and/or assets involved in the event, it becomes vital to have a coordinated approach to handle the situation. In such a scenario, having location information along with control system information flowing in through the sensors using IoT integration becomes an invaluable asset.

The benefits are:

- Enhanced call taking and dispatching capability for Emergency Response System (ERS)
- Significant improvement in quality & response time for emergency events.
- Improved coordination and delivery of resources from multi agencies
- Improved emergency recovery by analyzing events in spatial environment
- “Smart Addressing” wherein the call taker can easily identify the address
- Dashboard view of events to get a holistic view of current situations, required for senior officials
- Resource allocation and response plan enabling dispatchers to plan the response quickly and effectively

Online Delivery of Public Services: To get the maximum outreach for the services available to the citizens and to make the processes transparent, it becomes imperative to expose the services available to the citizens on internet. These services become external facing for the city departments.

The solutions can include:

- e-Citizen services: Pertains to public complaints and administrative procedures

- e-NOC and permit services: Responsible for issuing No Objection Certificates and various permits
- e-Health and tele-care services: offering medical care and support for citizens in remote locations

Digital solutions ensure that:

- Services are available to the citizens at their doorsteps
- 24x7 availability for services
- Transparency in processes
- Reduction in turnaround times
- Offices and departments move towards becoming paperless thereby promoting environment friendliness

Online Project Approval and Clearance

System: In tandem with the online delivery of public services, these services focus more on the internal facing aspect for the city departments and provide online interfaces for approvers and approval processes. Services like clearance management, permit approvals, granting of No Objection Certificates can be made online. The benefits of these services are:

- Faster approvals through more transparent clearance systems secure accessibility from remote locations reducing turnaround times

Platform for Communicating Plans and

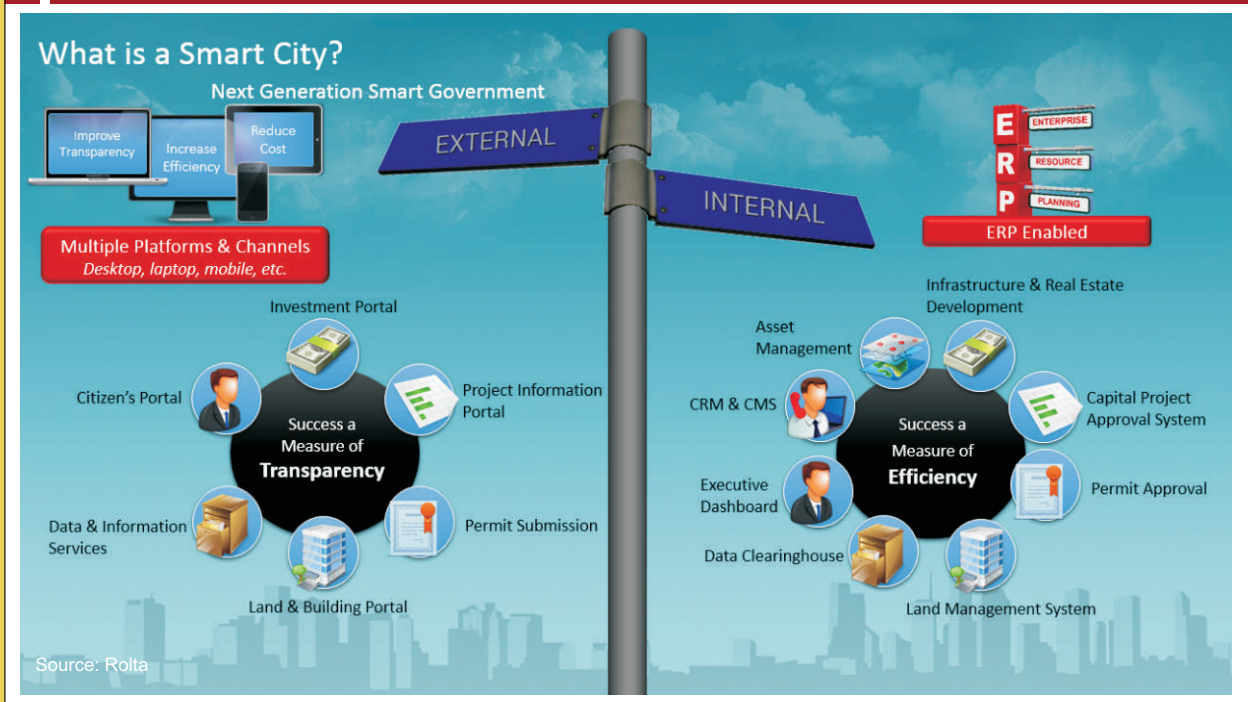
Activities: Active communication between the cities governing body and its citizens is essential for any city that aims to become a smart city. Thus it becomes necessary for city governing body to implement platforms and services which promote active dialog between its departments and its citizens. Services like eGovernment services and eDemocracy services will promote dialogue between the governance and public. It will allow citizens to understand the administrative procedures at local and national level, facilitate job searches, consultation, opinion polls and voting on issues of common interest amongst its citizens. This increases awareness amongst public and allowing governments to make informed and all-inclusive decisions.

Rolta's Recommended Solution/Application Framework for Smart City

Rolta's recommended solution application approach for smart city has its foundation in data services, which can include involvement with regional data service providers as partners. Wherever the organization or city department has data that exists as segregated information silos, these services can also include data modeling and migration. A variety of business systems solutions could be deployed on top of data services. These solutions can be categorized as internal or external facing.

- **Land and Building Portal:** Automate management of land records processes e.g. create subdivision, split/merge parcels and other land records processing. Facilitate registration and maintenance of real estate and property transactions. Allow citizens to search for land parcel titles, status on building permits and inspections etc.
- **Data and Information Services:** Geo collaboration portal for dissemination of spatial and non- spatial data

FIGURE 6 : Solution Approach for Smart City



External: These solutions are citizen facing and include:

- **Investment Portal:** Allowing smart cities to attract private real estate and infrastructure development (P3, BOT, BOOT)
- **Project Information Portal:** Allowing cities to communicate newly approved plans and projects to citizens
- **Permit Submission:** Issue all clearances for projects using online processes and in a time bound manner

- **Citizen's Portal:** Create a platform to effectively communicate with the citizens and keep them abreast of various activities and plans of the city. Inform citizens proactively during emergency situations including text messaging. Allow citizens to submit complaints

Internal: These solutions are internal to city departments and include

- **Asset Management:** Geocentric asset management solution across asset lifecycle

Synchronizes management across:

- I. The Asset Register
 - ii. External systems such as Project Management Information System (PMIS), FMS
 - iii. GIS
 - iv. Document Management System
- **Executive Dashboard:** Single place for executives and city department leaders to see everything that matters to them in a single screen that allows drill downs, and spatial visualization

The key solutions offered by Rolta in Urban Planning are:

- Urban data services creation of 2D and 3D models for city
- 3D model based simulation for urban planning
- Portal for crowd sourcing of city plan
- Property portal displaying property information based on search
- Utility network information system
- Land management platform
- Building plan approval system
- Geo-portal for urban expansion monitoring

FIGURE 7 : Rolta's Solutions for a Smart City



Source: Rolta

Urban Planning

Institutional, physical, social and economic infrastructure together form a city and are the key dimensions of a system which should be citizen centric, efficient, accountable and transparent.

Urban planning controls the development and organization of urban and rural areas. The following factors play a key part:

- Demographic distribution
- Landscape dimensions
- Transportation and utilities infrastructure
- Environment protection
- Framework or process to monitor and optimize planning and performance

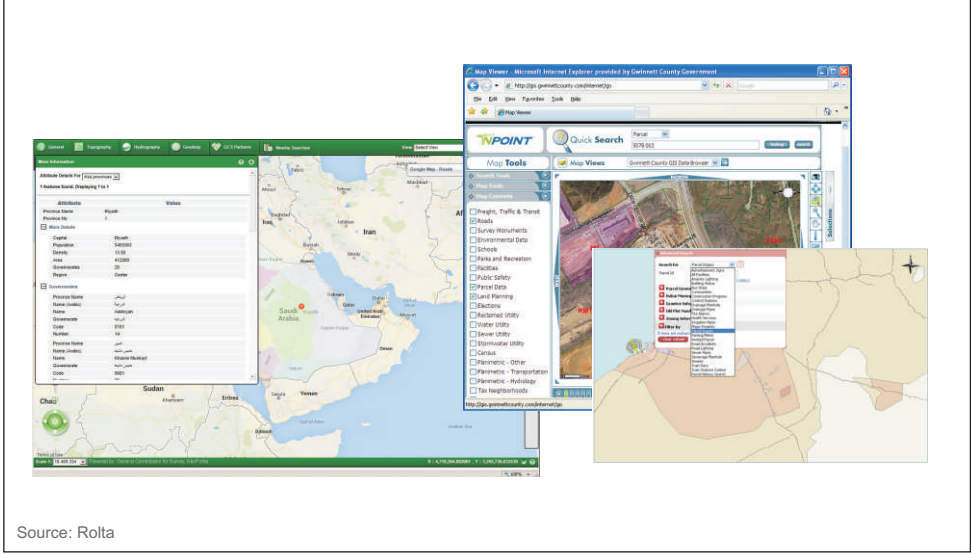
Illustrative Example: Crowd Sourcing

Any city needs continuous planning, i.e. the government caters to the growing needs and improves infrastructure services. Citizens can play an effective role in this planning, as they know the needs of their local area well. More and more governments have started encouraging citizens to give their feedback on the plans.

Rolta's GeoPortal solution helps to integrate the city development plan on a GIS platform. It allows users to highlight remarks and suggestions for specific geographical areas. The collective feedback is highlighted on a map.

Here is a sample of a collaboration portal. Information about the city infrastructure is

Figure 8 : Crowd Sourcing



Source: Rolta

disseminated to citizens. The portal allows citizens to suggest necessary corrections and modifications, thus making it more accurate.

Economic Development

Besides a better quality of life, employment and economic activities are key factors to attract people towards smart cities. One of the prime objective of the city is to attract investment from different industries thus creating sustainable economic development. This empowers the government with finance to invest in different areas like infrastructure, economy, technology, mobility, environment, people and governance. Developments in these areas create employment opportunities and decent living conditions for

every resident. Economic development therefore plays a vital role in the life of a city.

Rolta leverages its rich experience to address a wide spectrum of requirements for economic development like:

- Industrial land management
- Investor portal to visualize demographics, infrastructure and land to select suitable locations for businesses
- Single window services portal for entrepreneurs and corporates which automates the entire process of license grants and related permissions approval

Figure 9 : Industrial Sites Information Portal



Source: Rolta

Investors Portal

Illustrative Example: Industrial Sites Information Portal

A critical challenge faced by investors is getting authorized access to different business & market data, taxation policy, socio-economic data, infrastructure data and information about availability of electricity, water and other basic amenities necessary for setting up a business or industry. A deep understanding of the political landscape, trade regulations, policies and special permissions is also necessary for investors.

Rollta's Investor Portal solution enables organizations to visualize demographics, infrastructure and land to select a suitable location for a business, as well as strategize how to bring new investments into the city. In line with Gartner's recommendations for Smart Cities, this portal facilitates economic development by driving ability to foster an investment climate in the city that nurtures existing business and attracts new companies.

As illustrated, the solution enables:

- Information portal for industrial data, cluster information
- Demographic and economic reports
- Site comparison reports including site level reports from state, municipal on taxation, incentives, social & physical infrastructure

Information is made available with reports and analytics. This helps in mitigating risks and aids quick decision making, thus encouraging more investment in the city.

Smart Public Works

Public work authorities play a major role in building and managing the infrastructure of cities. These agencies are often challenged by increased regulations, environmental risks and constrained budgets, compounded by increased demands of customer service and delivery.

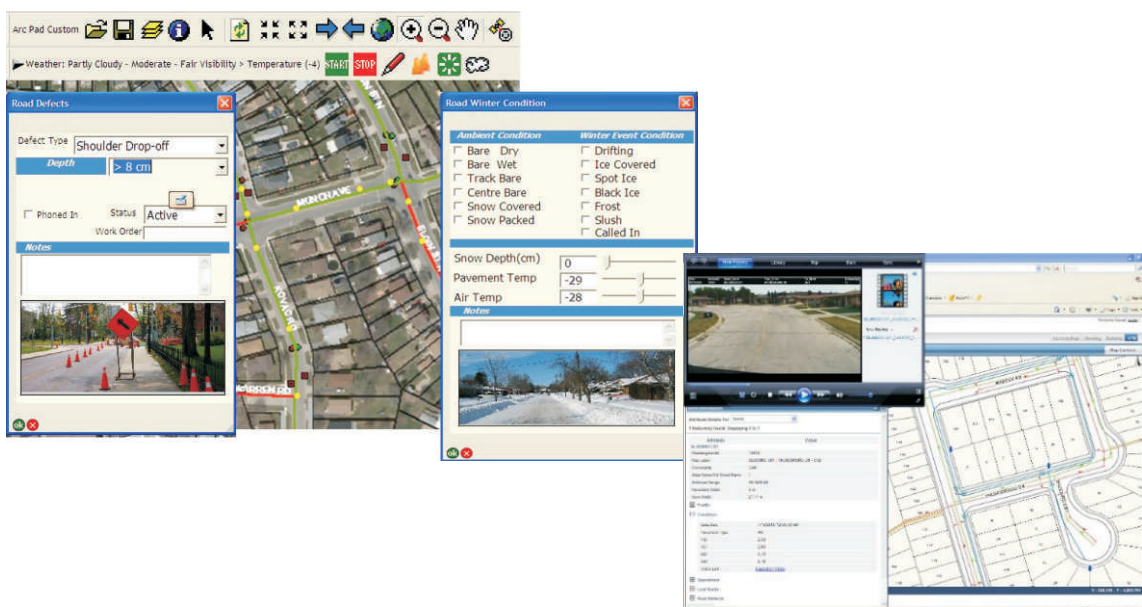
Rollta solutions for smart public works feature:

- Capital project management to provide an integrated infrastructure, project management platform supporting a backend ERP and finance system. It allows map based project planning and an integrated public grievance module
- Geo-asset management to support the entire lifecycle of public works assets
- Road monitoring application to provide local road network updates on regular basis

Illustrative Example: Road Monitoring Application

The road network is the lifeline of any city which needs to be maintained to have smooth transportation within.

Figure 10 : Road Monitoring Application



Source: Rollta

The Rolta platform allows smart city partner organizers to provide local road network updates on a regular basis. Designated contacts at local agencies use the geo-enabled portal to submit data to the transportation authority. The updates trigger workflows which distributes work amongst various members of the network maintenance teams. The platform has business intelligence dashboards to provide executive level visibility into the process.

- Integrated view of road defects, asset information and base maps
- Integration with work order management platform
- Work order display to mobile crew
- Better monitoring of road infrastructure and related maintenance activities

Smart Utilities

Smart utilities is an integral part of a smart city and is supported by smart operations which are reliable, responsive, safe, self-sustaining and continuously improving.

Smart operations face the following challenges:

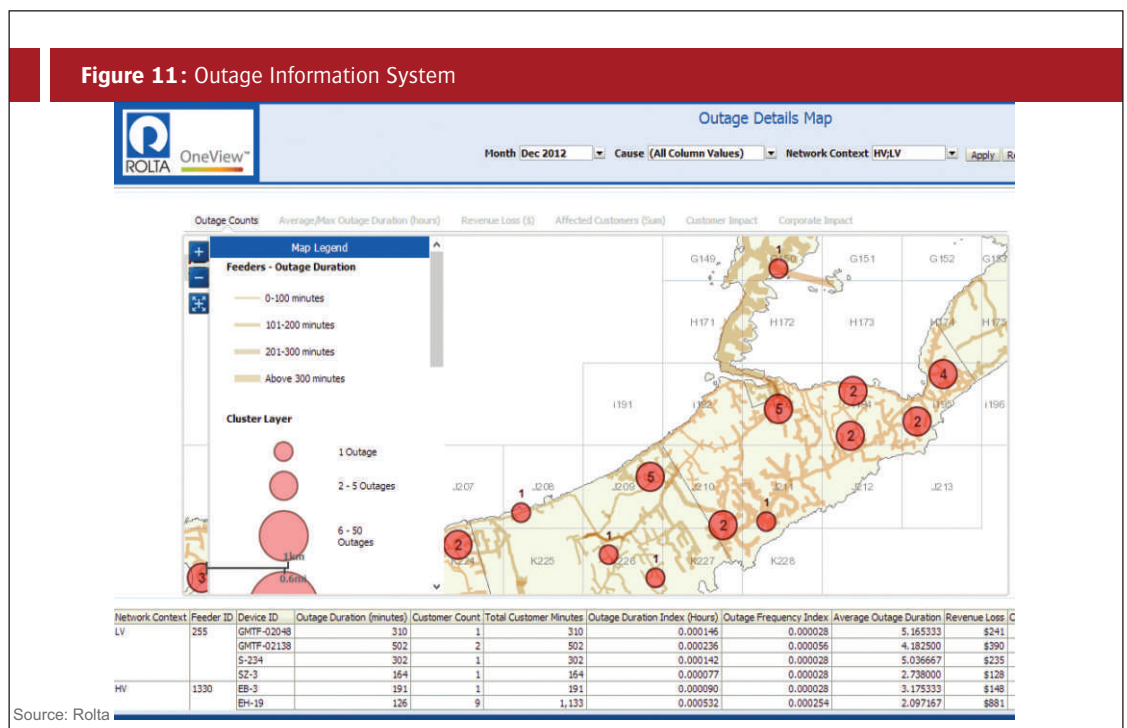
- Aging infrastructure
- Increasing operation expenses
- Utilization of assets and investment
- Regulatory compliance

- Growing population
- Expanding geographies of cities and so too its network

To overcome these challenges and meet expectations of smart operations, utilities implement capacity addition projects, take improvement initiatives and automate the functions and sub-functions.

Rolta’s solutions for smart utilities feature:

- Geo-asset management supporting end-to end asset lifecycle including its integration with planning drawings
- Geo-coding of assets and asset junctions with IoT integration
- Rolta OneView™ based performance dashboards which help in breaking down departmental walls and give macro and micro view of the entire operation along with supporting services, all as one entity
- Outage information system
- Mobile field inspection and task force management
- Work order management
- Safe to dig - geospatial platform to assist digging operations
- Consumer complaint analysis



Apart from generic solutions, Rolta provides specific solutions for each of the utilities industries covering

- Power distribution
- Water Distribution
- Gas Distribution
- Telecom operations

Illustrative Example: Outage Information System

Minimizing planned and unplanned outages is a very high priority. When certain work crews lack visibility of activities from other groups, it could result in an interruption of power. It is common that these interruptions occur from common work processes like maintenance, new construction and facilities upgrade.

Rolta's Geospatial Fusion™ based solution integrates various work orders on the selected geographical area, thus highlighting outage impact, if any. The outage is highlighted with various spatial visualizations, thus providing better details to the respective task force managers.

This visualization helps related groups perform coordinated activities reducing unplanned outages and thus improving customer satisfaction two-fold.

Rolta solutions feature advanced capabilities to integrate IT/OT systems spanning the smart grid against a backdrop of geospatial intelligence to provide highly contextualized resource-aware utilities management.

Smart Water Management

Water is an integral part of life and hence no smart cities can sustain without effective water management. Water utility is considered to be a traditionally regulated business with integrated model spanning production, distribution, waste treatment processes are under one roof. However changes are happening in this sector in past few decades. Organizational monopolies are expected to shift in near future with change in regulations. Industry needs to adhere to strict regulatory and environmental norms to maintain quality of water fit for consumption.

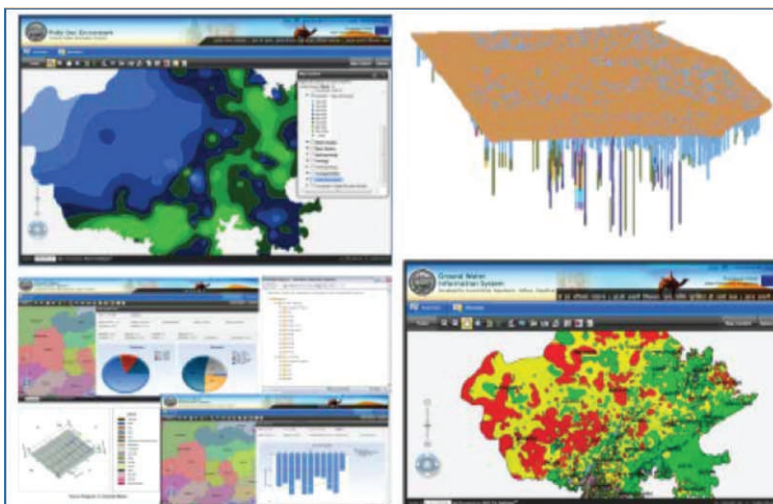
Rolta's solutions for smart water management enable:

- Water quality, inventory, leakage and service level monitoring & analysis
- Sewage line flooding analysis
- New connection compliance and meter to cash analysis
- Bad actors Identification, maintenance cost and schedule adherence
- Competency tracking
- Utilization of natural resources and OPEX / CAPEX analysis
- CSR compliance

Illustrative Example: Smart Water Management

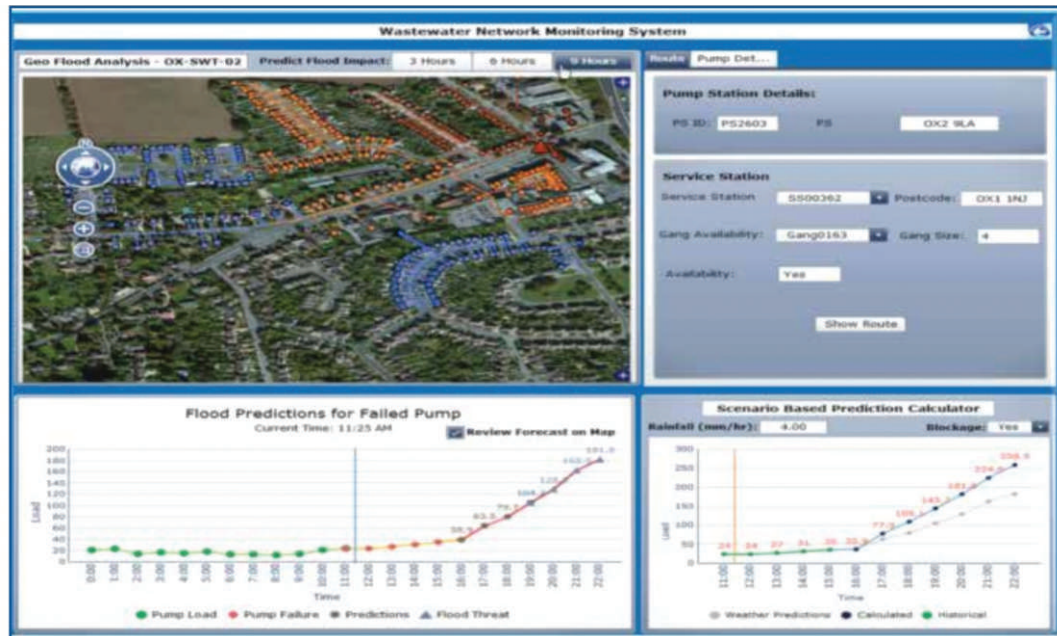
Smart cities need to feature integrated utility asset performance indices, customer satisfaction

Figure 12: Water Quality Geospatial Analytics with Isohyet Thematic Mapping



Source: Rolta

Figure 13: Disaster Management with Flood Prediction and Potential Impact Analysis



Source: Rolta

indices, with a drill-down to root cause analysis. The smart water management eco-system includes the sources of water, distribution network as well as sewage lines. Water utilities need a platform to provide macro and micro view of entire operation & supporting services as one entity. Having a single view of integrated cross departmental data helps utility administration to achieve operational excellence, plan projects better way, identify the root cause of repeated failures. For example Rolta OneView™ helps analyze potential asset failures and better plan disaster management by providing flood predictions and impact analysis. In this case effects of a failed pump and flood predictions in a specific geography are shown over a period of time. This enables scenario based simulation of potential impact and allows decision makers to coordinate across multi-functional areas proactively for risk mitigation.

Another example depicts how ground water management body uses Rolta solutions for advanced geospatial analytics to understand the availability and distribution of water. This helps effective planning for appropriate utilization of scarce water resources.

Smart Sewerage Management

A smart city needs a strong and efficient sewerage network. An efficient sewerage

operation needs effective asset management including monitoring of outage, CCTV integration for assets monitoring, workforce management and single-window clearance management.

Rolta's solutions for smart sewerage management enable:

- Single window clearance management for sewerage network
- Sewerage asset management covering entire life cycle management from planning till retirement
- Work order management
- Preventive maintenance based on sludge forecast

Illustrative Example: Sewerage Asset Management

City or statewide waste management and sewerage operations are spread across large areas with a variety of movable and immovable assets. These assets are in use on a daily basis, round the year which causes physical wear and tear. As a result, performance deteriorates over time and in worse cases they may stop functioning, posing a risk to human health and the environment. It is necessary to track the performance, operations and maintenance activities of these assets, to maintain smooth running of waste management and sewerage operations.

RoIta's spatial enabled solution platform allows maintaining assets in the sewerage department. The platform also allows for redundancy management. It provides a synchronized single source of information to monitor critical KPIs. It is a RoIta GeoAssets™ based, asset lifecycle and workflow management solution.

- Enables proactive CAPEX planning,
- Optimized expenditures on infrastructure assets
- Aids in funding forecast for construction & maintenance
- Elevated customer service and decision-making with expanded access to ERP data from the GIS map
- Maintain & manage asset information for enhanced asset life & performance

Solid Waste Management

Waste management (collection and recycling) is one of the biggest challenges in highly urbanized cities, which are in need of smart solutions to improve efficiency to a great extent. An effective platform and process for solid waste management reduces the impact on the environment and on human health, thereby providing a qualitative life for citizens.

RoIta's solutions for solid waste management cover:

- Spatial enabled environmental impact assessment
- Garbage bin collection monitoring platform with integrated fleet operations monitoring

Illustrative Example: Environmental Impact Assessment

A city's waste needs to be disposed of, following scientific methods to avoid any major impact on the environment. Increasing awareness of hazardous materials and their impact on the environment among citizens helps in controlling waste generation. At the same time, authorities need to have a platform to monitor the environmental impact of waste disposal so that required corrective actions can be taken.

RoIta provides a spatially enabled analytical platform to monitor solid waste data and the environmental impact of waste disposal. The platform has the ability to monitor data in a spatial context and build trends for further analysis by the government and environment agencies. Users can access their entire environmental data and analyze trends, as well as perform compliance reporting from one single application.

Trend analysis visualization on spatial platform helps in better analysis of environmental impact in surrounding areas. RoIta solutions leverage

Figure 14: Sewerage Asset Management



Source: RoIta

IP-based platform components that are loosely coupled, but can be seamlessly integrated. Accordingly, Rolta SmartCity components for Solid Waste Management work closely with other Rolta SmartCity solutions spanning Smart Utilities, Smart Transportation, Smart Public Services, etc. and can be quickly assimilated to deliver a comprehensive Smart City Operating Governance Framework.

Smart Environment Monitoring

While concerns regarding exponential population growth within cities, soil degradation and food supply may have eased over the past years, issues related to surface & groundwater quality, vehicular and industry pollutions, impairment remain of great concern for any city. Governments across the world are seeking to have geo-enabled enterprise resource planning tools to monitor environmental resources and infrastructure over time and locations.

Rolta's solutions for smart environment monitoring provide:

- Spatially enabled environment information portal
- Air quality monitoring platform assessing vehicular pollution
- Land scar monitoring platform

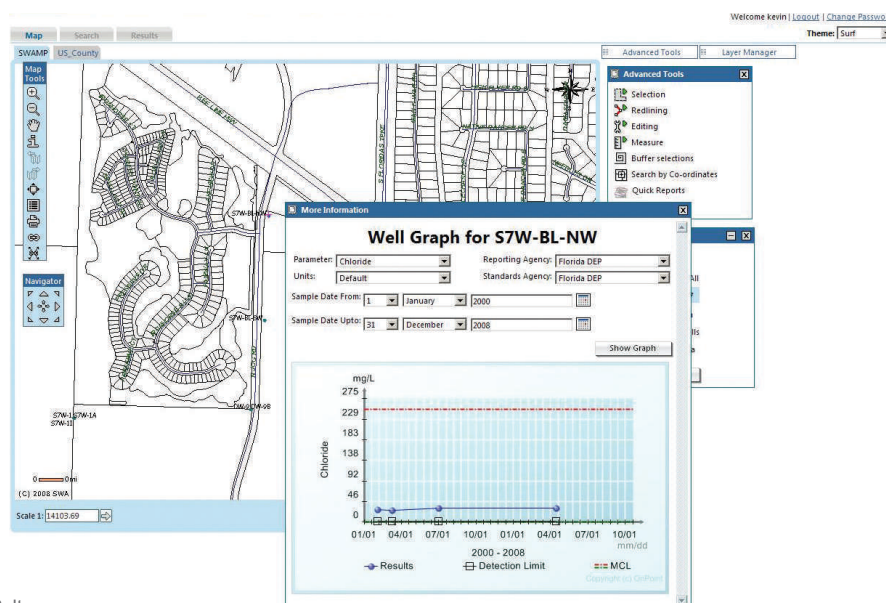
- Ground water monitoring solution
- Forest reservoir monitoring solution

Illustrative Example: Environment Information Portal

The environment is everyone's concern and maintaining it is the responsibility of the government, citizens and industries. Rolta Geospatial Fusion™ based, Portal for Environmental Information presents data for air, water, forest and land use associated with permitting, cleanup and enforcement interests. Together it provides a consolidated view of environmental features highlighting the changes. The portal increases awareness among citizens on environmental issues. It helps authorities monitor impact on a regular basis and to work on preventive or corrective action.

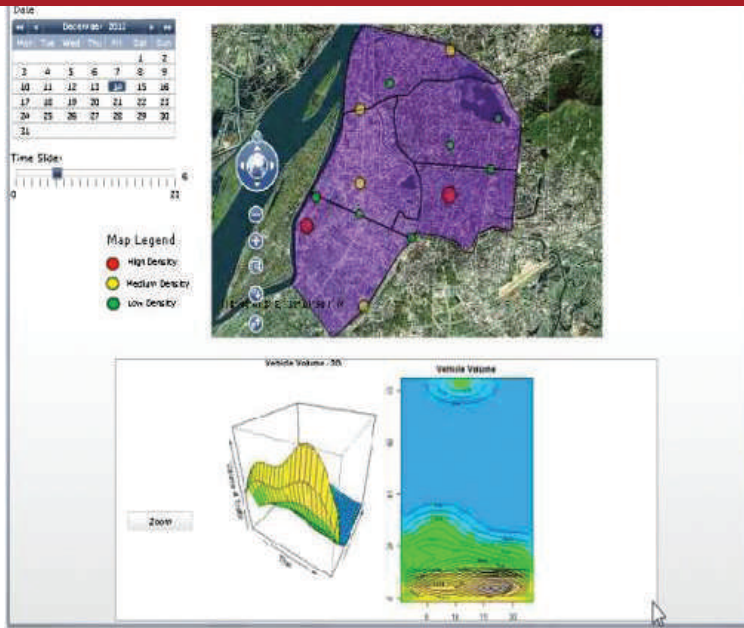
The approach is scalable across geographies. It is in line with Gartner's recommendations to "use smaller projects to establish best practices and to visualize first results since execution risks are lower, timeframes are shorter and transparency of who the stakeholders are is clearer" (Innovation Insight: Smart City Aligns Technology Aligns Technology Innovation and Citizen Inclusion). Rolta also has advanced health safety and environment solutions, which are industry-specific and organizational data feeds can be routed to Rolta Environmental Information Portal.

Figure 15: Environmental Impact Assessment



Source: Rolta

Figure 16: Emission Monitoring System



Source: Rolta

Smart Transportation

The transportation and infrastructure system in our cities and on our highways is stretched beyond capacity and unable to deliver the service that citizens and decision-makers desire. It is critical for transportation executives in smart cities to be able to understand their operational situation. This includes managing congestion, ensuring accessibility and system reliability; maximizing the availability and maintenance of assets, work projects and safety for all. This, needs

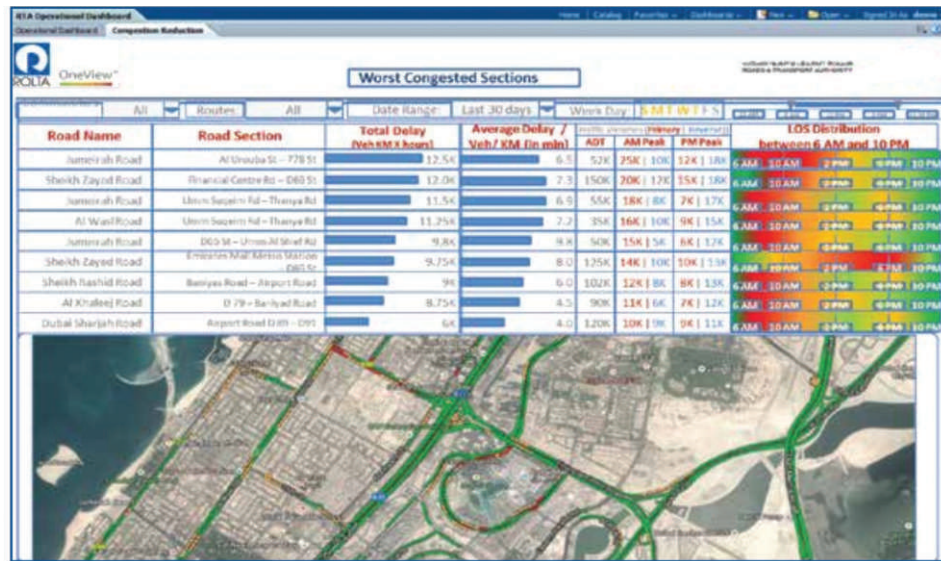
to be done within the available budget. What is needed is the ability to transparently access and integrate cross-functional data on a real-time basis and display both, the operational intelligence and location intelligence to provide transportation decision makers with accurate insights.

Figure 17: Managing Traffic Density



Source: Rolta

Figure 18: Traffic Information Portal



Source: Rolta

Rolta's solutions for smart transportation feature:

- Traffic information portal integrated with real time camera feeds
- Metro / Rail information portal
- Waterway management
- Road safety audit system
- Transportation infrastructure performance
- Traffic congestion analytics
- Road permit clearance system

Illustrative Example: Traffic Information Portal

Traffic monitoring is a key task of, not only the transportation & traffic authority, but also of police and other municipal administrative service centers. Having a centralized information system providing real time status of traffic network helps authorities to take necessary actions.

Rolta Geospatial Fusion™ based solutions provide a visualization framework for near real time monitoring of road networks with camera display feeds for traffic management.

The result is a single, map based system interface providing actionable insights to authorities.

Figure 19: Transportation Planning & Management



Source : Rolta

Smart Governance

With the aim of providing better citizen services the government has been aggressively pushing for eGovernance initiatives.

For a government to maintain effective communications with its constituents is always a challenge, given the increased desire for citizens to access services 24X7 and report issues faced by them. The need to inform citizens of vital matters affecting quality of life (such as road detours due to road maintenance, VVIP movement, etc.) is also a growing concern.

Rollta's solutions for smart governance include:

- Rollta GRP (Government Resource Planning) a combination of COTS and bespoke solution localized for civic body process automation
- Rollta Geo-ERP (Spatial Enabled ERP) building location intelligence to government operations
- Election management
- Encroachment management
- Facility and asset management
- Job management
- Fleet management
- Road sweeping monitoring
- Parking meter monitoring
- Single window citizen service desk

- Monitoring service desk infrastructure performance
- Citizen grievance management
- City performance dashboard
- Residential data hub
- City portal
- City mobile apps – find parking, find route, city guide

Illustrative Example: Single Window Citizen Service Desk

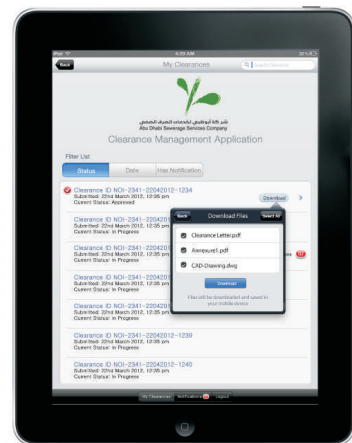
Citizens need to avail various government services like birth & death certificates, marriage certifications, domicile certificate, property tax payment, various utilities or services payment, etc. Rather than having disparate service center catering to each services, it is beneficial to have a common service desk catering to all services.

Rollta's single window services platform helps citizens to log & track their various service requests. The platform integrates the requests with an effective SLA bound workflow management platform triggering notifications to appropriate departments or service agencies to take required actions.

The platform helps save citizens time; helps authorities have integrated analysis around services performance.

Figure 20: Single Window Citizen Service Desk

Department	Date	Status	Notify
Elasat	11/03/2013	Approved	<input type="checkbox"/>
OU	11/03/2013	Supporting Documents Received	<input type="checkbox"/>
Public Parks and Horticulture	11/03/2013	In Processing	<input type="checkbox"/>
Roads Maintenance Section	11/03/2013	Supporting Documents Received	<input type="checkbox"/>



Safe City

From conventional street violence to dynamic crime horizon; protecting the city against crime, natural disasters, accidents or terrorism can only be tackled by increasingly sophisticated technologies and processes.

Rolta Smart Security/Safe City solutions facilitate securing urban environments with innovative crime prevention, distress call and emergency response management, traffic management, video surveillance and disaster management capabilities.

Rolta's Safe City solutions include:

- Real-time communication helping emergency services to intervene promptly
- Collaboration between agencies in a reliable and secure way
- Gather and analyze heterogeneous sensors and incidents information in real time
- Command and Control in collaboration with incident response teams and first responders
- Enabling municipalities and their emergency services to enhance safety and security for citizens, businesses, assets and infrastructure

City authorities want to have a unified view of various video management systems to have complete awareness of on-field activities. The platform should also be capable of consuming and displaying video on a need basis from public and private organizations during collaboration

Rolta Safe City provides the following:

- Common Operating Picture of security operations to operators & responders
- Interoperability, decision support & unified communications for multi-agency collaboration
- Full-fledged video support (camera list, live video, recorded video, PTZ controls, playback, video matrix)
- Enhanced support with GIS & video controls to get on-field experience
- Integrated intelligent distress call response management
- Real-time ability to quickly visualize multiple sensors data and activity patterns

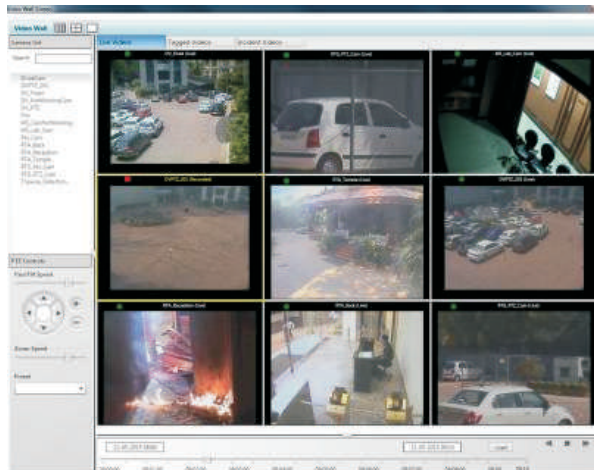
The solution provides decision-makers with the data needed for confrontation, response, management and analysis of a wide variety of emergencies and threats, including natural disasters, terrorist attacks, crimes & criminal cases.

Figure 21: Rolta SafeCity - Multi-Agency Collaboration



Source : Rolta

Figure 22: City Surveillance & Mobility



Source : Rolta

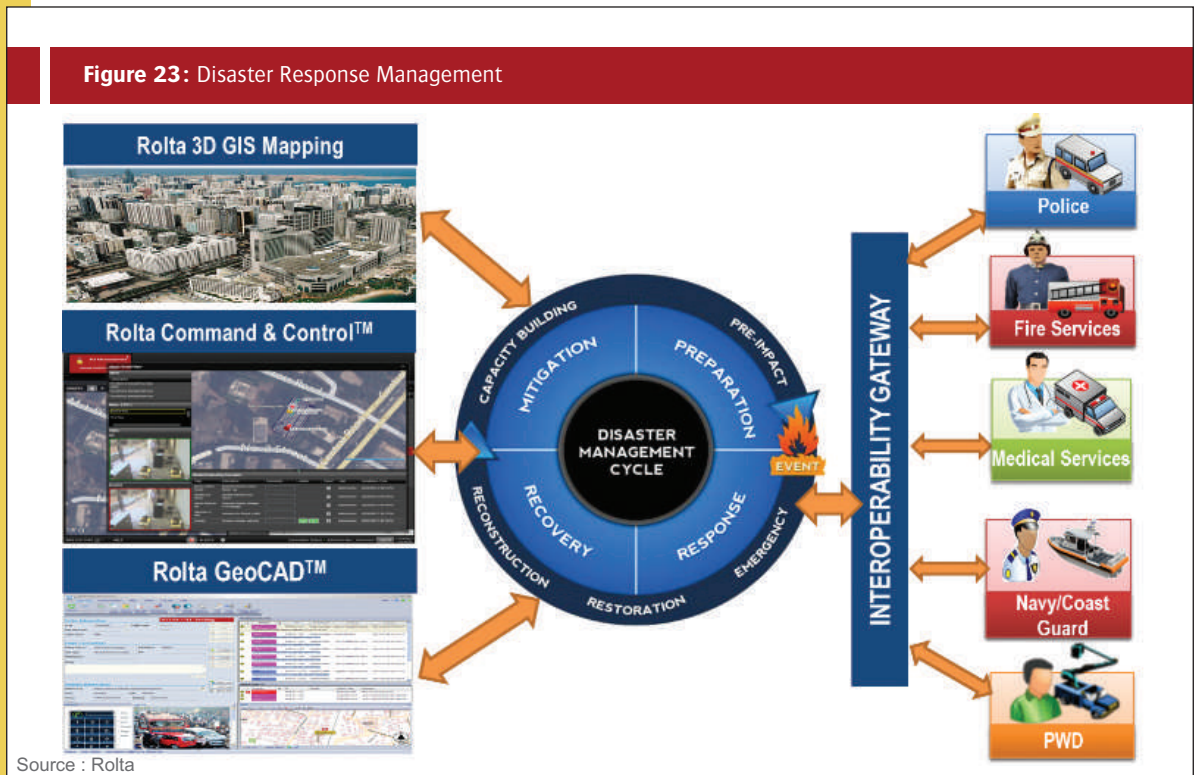
Disaster Management

It is crucial to have access to the most updated and comprehensive information when it comes to making effective decisions in the wake of a disaster. Rolta solutions feature disaster planning and management systems capabilities that enable a real-time, common operational picture across the smart city. The solutions not only provide a single point of access to a wide range of disparate data, but also encourage collaborative and effective communication and intelligent information sharing between stake holders and the key parties helping them, to enable disaster preparedness.

Rolta's solutions for disaster management address:

- Disaster simulation & forecasting (flood) supporting 3D model based flood simulation and spatial analytics
- Storm impact analysis on utilities assets considering weather parameters and asset threshold value
- Multi-agency collaborative framework for disaster management
- Disaster recovery and rehabilitation project MIS

Figure 23: Disaster Response Management



Illustrative Example: Disaster Response Management

Better disaster management is required to save lives and control damage to property. It is essential to have a real-time situation monitoring platform integrated with alerts & notifications.

Rolta disaster planning and management system enables a real-time, common operational picture. It provides a single point of access to a wide range of data ranging from sensors in the field to various disparate systems. It also encourages collaborative and effective communication and intelligent information sharing between stake holders and the key parties helping them, to enable disaster preparedness. It provides a centralized helpline-based dispatch solutions for distress calls.

Geospatially enabled - real time monitoring of sensors and systems providing Common Operating Picture (COP) of the current situation. Better monitor distribution performance, asset failure scenario analysis, etc. The solution spans across machine to machine (M2M) networks, enables IT/OT integration, consumes application aggregation and provides business analytics.

Conclusion

Smart cities are garnering increasing mindshare on account of promise to deliver better citizen services and improved governance, thereby elevating quality of life across socio-economic strata. Policy makers and thought-leaders across the globe are exploring Information Communication Technology (ICT) interfaces to definitively guide and drive emergence of smart cities from existing coordinated chaos. The thrust is to bring in policy transparency and economic growth, promote urban inclusion by expanding digital frontiers, drive collaboration, community and citizenship involvement, factor-in service and ecosystem diversity, ensure urban sustainability and infrastructure efficiency, while delivering higher value citizen services.

Rolta – a pioneer in the fields of integrated ICT, geospatial and advanced analytics solutions has been working for more than two decades with governments across the globe to provide better services to citizens, and facilitate desirable environmental, social and economic impacts. Rolta has been awarded for its wide range of smart city solutions. Rolta offers over 100 solutions across multiple verticals, with 400+ implementations in use around the world.

As an innovative provider of unique solutions, Rolta leverages its rich domain experience gained across eGovernance projects, and latest technology skills to deliver IP-based smart and safe cities solutions. These solutions feature technology convergence covering machine to machine (M2M) communication networks, IT/OT middleware integration, Internet of Things (IoT), mobility, social media, cloud, geospatially enabled aggregated transaction application systems, master data management and secure role-based big data analytics capabilities. Rolta advisory and solutions span the complete technology stack recommended by Gartner for smart and safe cities. Rather than re-inventing the wheel, Rolta innovatively combines its niche IPs, rich library of project accelerators, existing third-party technologies used by customers, and services to deliver Smart City Operating Governance Framework. Rolta provides a complete spectrum of Smart City Solutions including Urban Planning, Economic Development, Safety & Security, Governance, Local Government, Transportation, Water Management, Environment, Waste Management, Power & Gas distribution, Public Works and Disaster Management.

Source : Rolta



Rolta SmartCity Solutions

Urban Planning

- 2D/3D City Model
- 3D City Model Based Planning
- Land Management
- Electric Infrastructure Management
- Gas Infrastructure Management
- Pipeline Infrastructure Management
- Water Infrastructure Management
- Municipal Spatial Solution Infrastructure
- Crowd Sourcing for City Planning
- Building Permit Approval
- Transportation Engineering System
- Property Management
- Urban Expansion Monitoring
- Property Network Analysis
- Flood Simulation & Management
- Disaster Impact Analytics



Public Works

- Capital Project Management
- Enterprise Geo-Asset Management
- Safe to Dig
- Mobile Field Inspection
- CAD to Map
- Work Order Management
- Customer Complaint Analysis



e Governance

- Citizen Portal
- Single Window Citizen Service Desk
- Citizen Grievance Management
- Citizen Mobi-connect – Find Parking
- Citizen Mobi-connect – Find Route
- Citizen Mobi-connect – City Guide
- State Residential Data Hub
- Service Desk Infrastructure Monitoring
- Single Access for all Government Applications
- Billing Management
- Rolta GRP (Government Resource Planning)
- Rolta Geo-ERP (Spatial Enabled ERP)
- e-Procurement
- Project Management
- Facility Management
- Election Information
- Encroachment Management
- Job Management
- Fleet Management
- Road Sweeping Monitoring
- Parking Meter Monitoring
- Road Monitoring
- Mobile - Field Health Workers
- City Performance Dashboard



Power

- Enterprise Asset Management - Power
- Power Asset Junction
- Power Outage Monitoring
- Transmission Infrastructure Project Management
- Energy Meter Billing Analytics
- Power Distribution Performance Management
- Operational Excellence
- Predictive Asset Health Analytics



Water

- Water Resources Information System
- Water Tank Information System
- Water Quality Compliance Monitoring System
- Water Distribution Performance Management
- Waste Water & Clean Water Performance Analytics
- Asset Performance
- Investment Planning
- Operational Excellence
- Geospatial Pipeline Integrity
- Flood Simulation & Management



Waste Management

- Bin Management System
- Solid Waste Disposal
- Sewerage - Asset Management
- Preventive Maintenance Based on Sludge Forecast
- Single Window Clearance Management
- Sewerage Flooding Analysis



Disaster Management

- Disaster Response Management
- Disaster Rehabilitation Projects MIS
- Emergency Management Spatial Data Support
- Medical Emergency Response



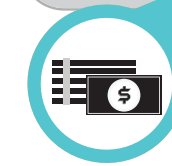
Safety & Security

- Rolta GeoCAD - Multi Agency Emergency Response
- Security Planning - Police
- Patrol Planning & Compliance Monitoring
- Distress Call & Emergency Response Management (Police)
- Medical Emergency Response
- Distress Call & Emergency Response Management (Fire)
- Rolta Suraksha
- Rolta Command & Control for Safer Cities
- City Surveillance
- Critical Infrastructure Protection
- Airport Security
- Coastal Security
- Vessel Traffic Management
- Crime Analytics
- 3D Model - Line of Sight & Line of Area



Environment

- Environment Management Portal
- Air Quality Monitoring
- Land Scar Monitoring
- Ground Water Monitoring
- GeoEnvironment - Soil Mapping Analysis
- Forest Reservoir Monitoring
- River Pollution Monitoring



Economic Development

- Industrial Land Development
- Investor Portal
- Single Window Clearance



Transportation

- Traffic Portal
- Metro / Rail information Portal
- Waterway Management
- Road Safety Audit System
- Road Permit System
- Traffic Challan Management
- Traffic Congestion Analytics
- Transportation Infrastructure Performance
- Asset Safety
- Transportation Planning & Budgeting
- Performance Analytics



Gas

- Gas Distribution Performance Management
- Gas Meter Billing Analytics
- Gas Asset Junction
- Geospatial Pipeline Integrity

Innovation Insight: Smart City Aligns Technology Innovation and Citizen Inclusion

25 April 2014

Analyst(s): Bettina Tratz-Ryan, Andrea Di Maio, Alfonso Velosa, Nagayoshi Nakano

Increased population density complicates the task of adjusting city infrastructure according to population growth. IT leaders should look to Smart City as an innovative and comprehensive framework that uses ICT to generate a sustainable, contextualized and more citizen-centered service environment.

Key Findings

- Each city or urban region sets its own unique priorities on social, environmental and economic drivers. This makes technology blueprints difficult to apply.
- Smart City will become more than a multilevel application environment with singular or integration of socioeconomic value.
- Few vendors have built a comprehensive ecosystem, proposing instead single-vendor solutions. Consequently, planners must be prepared for complex vendor ecosystems.
- The foundation of "smartness" in cities is information management and aggregation. These elements are blended with services and applications to satisfy citizens' perception of the quality of life and the work environment.

Recommendations

IT leaders:

- Identify the road map for embedding smart solutions into technology architecture and information process, and invest in horizontal or vertical domains to enable it.
- Analyze the maturity of solutions in terms of scale and commercial availability.
- Insist on technology and communications, as well as machine to machine (M2M) and Internet of Things (IoT), as the essential first steps toward building a solid architecture for Smart City. Investigate if the solutions approach will enable impact measurements of policy and solutions on residents and businesses.

- Develop an integrated governance view of network, IT, technology and service platforms, and align business models around it. Visualize the process and information flow that is creating contextual services for citizens.
- Use smaller projects to establish best practices and to visualize first results since execution risks are lower, time frames are shorter and transparency of who the stakeholders are is clearer.

Analysis

Innovation Description/Definition

Cities today represent coordinated chaos:

- Coordinated because we know the basic functions of city hierarchies: citizens, administrations and support functions
 - Chaotic because of the wide range of personalities of citizens, as well as the reasons they choose to live in an urban region or a specific city instead of somewhere else
- Aligning support functions (such as housing, electricity, education, healthcare and economic wellbeing) to the individual needs of citizens often depends on a city's overall strategy, and it can be extremely complex. Cities must constantly balance the challenge of resource constraints against environmental sustainability concerns and the cost of support functions, such as maintaining air quality and the energy and water supply, as well as waste management and carbon reduction — services that are often demanded by citizens or mandated by government stakeholders.

At the same time, cities represent an extensive melting pot of innovation potential. According to a 2008 United Nations (UN) report on population distribution, urbanization, internal migration and development,¹ more than 80% of all patents in Organisation for Economic Co-operation and Development (OECD) countries are filed in urban regions. Knowledge exchange in schools, universities and laboratories leads to pilots of cities as innovation labs where technology innovation

is married to services and business models to create more contextualized citizen (residential and enterprise) benefits.

Consider these two examples as possible scenarios:

- Connected devices and sensors in homes offer senior citizens the ability to live safely and comfortably in their own homes versus in a nursing facility. Biometric face recognition can detect changes in facial composition of the elderly person and determines dehydration or state of irritation or dementia. The alert triggers interaction with the person being monitored to identify colors or moving images, and failure to do so will create a notification call to social services, an emergency telephone number or the neighborhood watch.
- Commuter traffic can be influenced by understanding daily commute preferences, such as routing, business environment of the commuter, information on events close to or near the commute route, accidents, weather patterns, parking availability and the like. This helps people choose among different modes of transportation, not only saving time with more efficient ways of travelling, but also impacting each other's commuting patterns when sharing journeys (see Note 1).

The Scope and Promise of Smart City

None of this would be possible without Smart City — an urban planning and city topology design utilizing a comprehensive information and communication technology (ICT)-supported framework. Gartner defines a Smart City as “an urbanized area where multiple sectors cooperate to achieve sustainable outcomes through the analysis of contextual real-time information shared among sector-specific information and operational technology (OT) systems.”

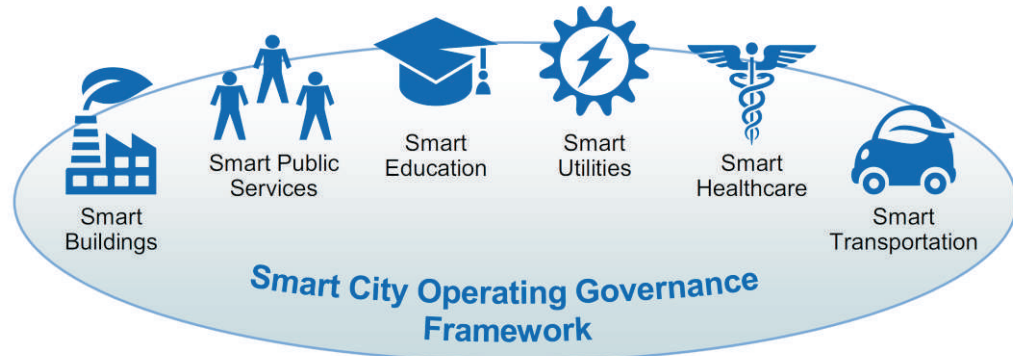
Throughout this report, we will use “Smart City” to refer to the concept or framework (see Figure 1). “Smart cities” (not capitalized) will refer to areas that are arguably already operating with at least a rudimentary version of the Smart City framework.

The interactions between sector-specific and intersector information flows result in more resource efficient and sustainable business models and lifestyles. That interactive and analytical information exchange is making the sectors intelligent or “smart,” since they are not only following their own benefit, but are also optimizing Smart City operations as part of the community and ecosystem.

The road map of cities' approach to Smart City — and the degree of innovation in technology, services and information management — depends on the priority of the benefits and drivers listed below:

- **Urban inclusion:** Expanding digital and social inclusion, often initiated or supported by national policies to abolish the digital/broadband divide of all citizens, regardless of status, nationality and age.
- **Collaboration, community and citizenship:** Development of community-driven valued services, often supported by connected voluntarism in times of emergency across agencies. This includes collaborative design and participation, often in an online app store development environment.
- **Service and ecosystem diversity:** Generation of service availability from multiple yet connected providers, where the city is operated as an innovation lab to obtain best-of-breed services, applications and technology environment. This also includes ecosystems for smart buildings and integrated service environments.
- **Urban sustainability and infrastructure efficiency:** Resource awareness and management of utilities, transportation and traffic network, which helps reduce carbon dioxide emissions, energy consumption and noise levels, while also improving air quality, parking availability and traffic flows. Energy and utility investments in smart grid operations, energy management and efficiency are key enablers here to develop new operational benefits.
- **Urban policy, transparency and economic growth:** Urban policy toward smart cities is expressed in governance frameworks that determine the internal and operational benefit of Smart City policies, such as emergency

Figure 1. Smart City Operating Governance Framework



Source: Gartner (December 2012)

response and command and control. Transparency of the decision-making process is critical to determining the road map of deployments and the ownership of the Smart City information.

- **Citizen services:** The distinct citizen services that are generated through the contextualized information exchange can be offered through many different channels: government agencies, public entities, service providers, public/private partnerships and businesses. The government and operations view will be looking at Smart City predominantly in an operational efficiency and process alignment perspective, in the form of government governance domain — including open government initiatives and digital inclusion, as well as compliance to other national initiatives.

Context

Urban areas consist of physical clusters, such as buildings, business parks, residential areas and corporate locations — or even entire cities or groups of different cities (urban regions) connected with each other. Examples are the Northeast corridor from Boston to Washington, D.C. in the U.S. or the Delhi-Mumbai Industrial Corridor in India.

Different industry sectors operate within each urban area — such as the public sector, utilities,

education, transportation and healthcare. Several sector-specific systems can be developed and optimized to contribute to urban-area-wide sustainable outcomes, such as advanced metering or network sensors for utility networks or traffic sensors for congestion charging. While better use of information can make each sector smart, Smart City requires that sector-specific information be shared across all sectors to influence overall city performance.

Innovation in Smart City development requires a holistic and sustainable approach to leveraging the sharing and exchange of information if it is to generate value for all urban stakeholders. While information is a key ingredient to drive the efficiency of network systems, the advantage to stakeholders (such as citizens and users of the infrastructure) is not always obvious. Public-sector and related utility investment in urban development often starts in infrastructure enhancements, such as transportation, roadways and parking, as well as municipal water, electricity grids or public buildings. Those investments are helping cities and public entities optimize their infrastructure and delivery model, which reduces administration and management expenses. Service revenue will not be driven by network efficiency. However, cities and their third party providers can use information to build out services and applications that visualize energy and carbon reduction. For example, New York's PlaNYC is driving major energy efficiency initiatives for buildings to reduce the overall carbon emissions of New York City 30% by 2030.

The ability to share and exchange information across an entire urban area ecosystem will both contribute to better citizen services and create revenue and efficiency improvement opportunities for all enterprises involved. The combination of improved citizen services, increased operational efficiencies and new revenue streams will determine the success of a Smart City beyond environmental efficiencies.

Business Impact

Scope of Deployment

Approaching the development of a Smart City master plan that will guide deployment of technology and solutions depends on a combination of elements, including governance structures, business models and decision-making frameworks. Basically, there are two ways to approach it.

At one extreme is the "greenfield" model approach, where the urban area is developed from scratch, with little reliance on existing infrastructure and support. While this enables the use of state-of-the-art solutions and technologies, it also requires significant upfront investment in basic infrastructure. Greenfield models generally emerge in situations where planning and governance are more centralized, with a strong private-investor-based commercial interest and real estate development model. Examples include Living PlanIT in Portugal, Songdo in South Korea, Masdar City in the United Arab Emirates and Innovation City in Russia. Greenfield projects are often very attractive from a PR perspective, but they take a very long time to develop from concept to execution.

The alternative, the so-called "brownfield" model, targets existing or abandoned urban areas. While smaller in scale than greenfield models, brownfield models still require updating/upgrading of existing infrastructure, as well as the mechanisms to deliver citizen value in terms of living and working in those areas. The scope of brownfield projects depends on the priorities and commitment of stakeholders in different government and industry sectors. Such projects also require collaborative forms of governance between city and private investors and industry. Examples of brownfield models include harbor areas in Stockholm, suburbs in London's East End and empty lots in downtown Frankfurt.

Business Impact of Urban Development

Agreement on benefits and outcomes is a key precondition to a sustainable urban development plan, including the characteristics of information, types of innovation, technology solutions and partnership models. Expectations must be clearly defined not only in terms of citizen values, but also in terms of business objectives for sector stakeholders (for example, market share, revenue generation and cost optimization).

Relevant outcomes can be grouped into environmental, social and economic categories.

Environmental

Stakeholders who are driven by environmental outcomes are interested in things such as the stabilization of energy or water grids in urban areas, or the reduction of pollution levels from different sectors, such as traffic or utilities. These concerns can be broadly categorized as:

- Air and water quality
- Physical plant utilization
- Grid efficiency ratios
- Carbon dioxide emissions per capita/person
- Number of vehicles in the designated area
- Number of passengers for public transportation

In the EU, metrics on sustainability have been defined for different sectors and projects. These include environmental metrics, with outcomes identified via assumed qualitative benefits for citizens and businesses — benefits such as improved water quality, reliability in energy supply and decreased traffic value. Utility- or government-related metrics center more on operational cost savings, better infrastructure performance and improved reliability.

Information sharing and exchange relating to environmental issues will enable utilities to contextualize air quality in terms of improvement in health statistics, water quality with improvements in food safety, or energy consumption related to renewable energy and constant energy supply.

Social

Social aspects derive directly from citizens' awareness, and they tend to be more emotionally driven, more subjective and more polarized in nature. Socioeconomic factors include cultural diversity, equal opportunity, aging and changes in social networking, as well as education and professional development. In many urban areas, IoT and wide connectivity via M2M are key components for this development. This extends even to neighborhood-level competitions on green and sustainable behavior. One such example was seen in Japan after an energy shortage, in which residents competed by exchanging the most innovative energy-saving tip for the home through a social media portal hosted by NTT. Business impact could come from in-home healthcare, elderly care, telemedicine, translation services, and public services in different cultural and language settings, as well as distance learning and smart home application models. Statistical metrics include:

- Number of internationalized/localized online applications
- Number of in-home service subscribers
- Participants in public crowdsourcing by public administration

At the heart of these various models we find that services, applications and innovation are often intertwined in the quest for more sustainable approaches to business and personal city issues. All manner of service arrangements can be determined when information about the condition of a citizen is available to be shared with social services, the transportation community, healthcare providers and the utility system. However, in many countries, regulations about the details of information exchange are still not resolved. That also includes privacy and policies about authentication and transparency of available datasets in the communications environment.

Economic

Economic development is a core component for a city government, and it is contingent on local taxes — such as sales taxes and real estate taxes — along with national and international investments within a city's urban areas. While emerging tax models, such as congestion or time-

of-day charging, are helping cities raise revenue via transportation, these will provide only short-term revenue to the city or transportation authority.

Economic development is often generated by the ability to foster an investment climate in the city that nurtures existing business and attracts new companies. Cities can also introduce measures to reduce their operating costs by using a different technology, such as light-emitting diodes (LEDs) in public lighting (see "Case Study: San Jose's Intelligent Streetlight Program"), or employing automation to reduce the energy consumption of public buildings. Metrics to assess the economic impact of a Smart City strategy include:

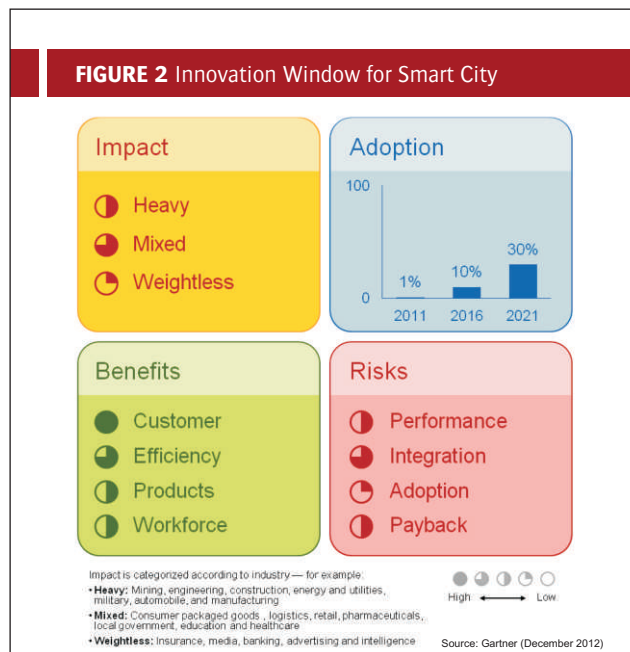
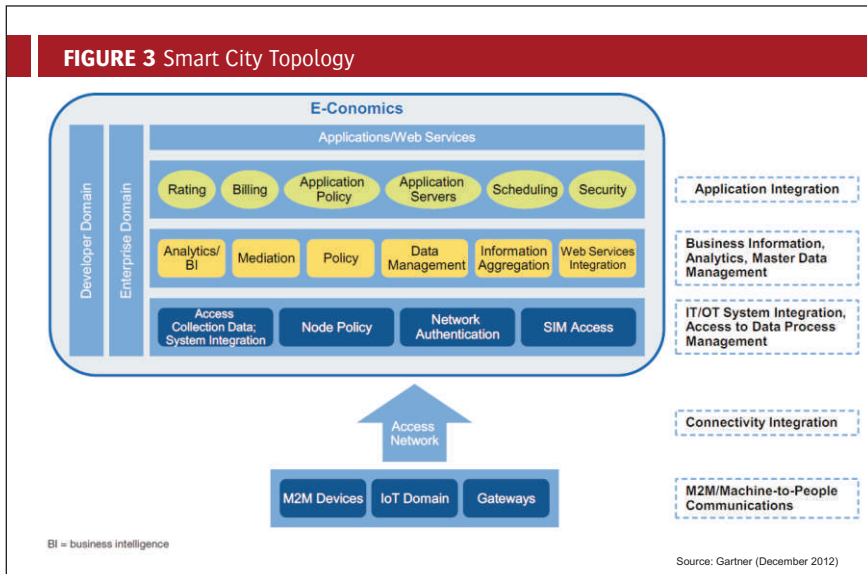
- The level of foreign investment
- Fiscal revenue increases
- Investment dollars in GDP
- Operational cost savings
- Net number of companies created

Innovation Impact Window

As shown in Figure 2, the Smart City framework will impact all industries that are conducting business in urban environments. The public sector is most highly affected. It will undergo significant changes, especially municipalities and city administrations. People in these sectors will need to engage in a more interactive way with different private organizations and industries, such as utilities and transportation. Citizens will demand more access and transparency in obtaining service support from city agencies. Smart healthcare and senior citizen care will emerge, leveraging information gathered from citizens and service industries.

Heavy industries — mainly, energy and utilities — are also heavily affected and will need to create new energy-efficient grids in neighborhoods and cities. Those industries will also need to develop new service architectures that are interactive with enterprises, buildings and citizens.

The automotive industry will also face a transition by connecting electric vehicles to electricity grids filled with information on the most efficient charging stations aligned with specific user profiles. Weightless industries, such as insurance and media, will have less exposure to smart cities.



IT Impact

To assess the IT impact, a theoretical technology stack of Smart City architectures must be explored. Figure 3 provides an overview of those layers.

Connectivity and Integration

Smart city and urban regions apply a wide range of operational and information technologies, as well as information sharing/exchange among the various networks. The utility grid, roadways, facilities management and telemetry systems, for example, are essential elements to optimizing efficiencies and service opportunities. The “glue” between information management and the operational domain is the connectivity

network. This acts as an intelligent platform that coalesces the many sensors, devices, RFIDs and Near Field Communication (NFC)-enabled assets into an ecosystem of units called the “Internet of Things.” Mostly classified as M2M, this network can provide connectivity to a wide variety information sources.

Integrating the operations network and the communications network is particularly critical and complex, whether this is to develop intelligent and IP-addressable sensors in roadways, or intelligent meters in grids to indicate electric vehicle charging preferences (see “Predicts 2013: IT and OT Alignment Has Risks and Opportunities”).

Communications Network M2M

A critical element for smart cities and urban development is a solid communications network that can leverage IoT either through a managed, structured approach in mobile communications, or via fixed networking. Fed by a variety of end devices, including meters, sensors, car navigation systems and access nodes in vehicles, M2M will generate huge amounts of data that will need to be classified in terms of usability as well as information context.

The device environment can communicate information to different providers to integrate this information into meaningful context. The task of integrating those managed and nonmanaged devices presents a formidable challenge in terms of the intrusion of security into the information or data collected from IoT. On the other hand, IPv6 will allow those devices to have IP addresses that can be managed remotely, so those endpoints will not only be one-way communicators, but also be able to react and act on certain commands. For end-user organizations, that will escalate the management domain of the end devices not only from the connectivity perspective, but also from the ownership and access perspective.

IT/OT System Integration and Access to Data Process Management

Smart City requires a robust communications network and IT interface. The IT network must integrate the management level of operational technologies as well. This should enable the streamlined collection of data flows to develop a framework in which information and data should be collected in a sequence that can be usefully linked to a process, as well as show how this process should be set up. The process owner is most likely today a sector, such as a utility provider, logistics company or transportation authority. Integration between the IT-enabled system base and the OT is often very complex.

In the OT sectors, embedding IT systems or IT/OT management systems is often difficult due to the broad range of nonstandardized interfaces and methodologies used to capture and transport information. Many companies have started to build proprietary systems (for example, on the communications provider side) that require IT/OT

system integrators to manage the network. In addition, there are nodes in this layer that analyze the data and information and sort it by priority to move up to the information layer.

Third parties that are getting access to data flows in a nonaggregated form will clearly be challenged to develop their own linkages and context-specific services. IT system integration identifies the standards that the data and information flow has to be attributed to in order to allow meaningful analysis.

Security protocols that ensure physical and IoT side security are also included here, to ensure that the data can pass to the master data management and database repositories. In some regulatory environments, information ownership is already determined on the process policies when information and data is collected and passed through process management to master data management.

Business Information, Analytics and Master Data Management

The most significant layer in a Smart City architecture is at the master data management and data aggregation level. That's because the aggregation and the information links will be created here, not only in relation to the regulatory environment, but also in the context of information services and transactions, billing, authentication, and consumer and business profiles.

Smart City application providers and vendors will be dependent on the access to this layer (see "Cool Vendors in Smart City Applications, 2012"). They need to integrate information sets into their database and service environment, which requires transparency on the syntax of the information shared, as well as the aggregation and the profile methodology.

The master data management layer is sometimes confused with city operations and command systems, which represent an integrated management platform for different processes in cities. City operations and command systems are often connected to information system middleware, which provides selective value-added information for specific event triggers.

Application Aggregation and Application Domains

Application aggregation and application domains are central to building models for the business environment that are based on the datasets available through privacy and data protection. Also, different application models and environments can be established by building from the validity of the aggregated data. Citizen platforms that share information and certain data on location, events, community services and so forth can utilize generic apps that can be plugged into the open layered architecture.

On the other hand, some cities use application domains as a competitive differentiator, accelerating the usage of application platforms by participating in pilots such as those of the European Commission. Depending on the domains, the applications can be quite sensitive and contextualized, such that the provider needs to apply filters and access processes for permissions to offer services to different citizen groups, such as the elderly, families or welfare recipients. This layer is also dominated by the business question of who is the trusted provider of applications and services, and who could charge for those services.

"E-Conomics"

The entire architecture is embedded in a transactional, billing or brokering domain that will create revenue-bearing models from this information flow and exchange. The applications and services can be quite transactional in terms of clearinghouse or billing models or marketing/channeling, as well as handoffs between access and service contracts (roaming, for example, as in electricity roaming). That domain requires the integration and transparency of user profile information in subscription as well as in opt-in form, but it can also be used in a community openness model.

Adoption Rate

Many of those intelligent information handshakes are still under regulatory constraints, which means this information is restricted and cannot be shared or owned by different parties.

Smart City and urban planning is transformational in its approach, especially for countries such as China, where the government is mandating the development of the strategy for all major cities and urban corridors. The scale of these initiatives should not be underestimated, and nor should the large portion of OT, which is costly and takes time to deploy. In most deployments to date, the Smart City process is executed at a more evolutionary pace. Smaller projects are being defined within the larger Smart City umbrella and are more transparent than large projects. Some projects identify a specific decommissioned lot or area of the city, which is converted into business parks with residential quarters, as well as schools, stores and so on. Such projects, rather than being large overhauls of entire cities, pinpoint to specific requirements of and benefit to residential and business citizens.

The smart governance operating framework is one methodology for achieving a structured approach on the city side to identify projects, their stakeholders and an execution path. This framework is emerging in Gartner's "Hype Cycle for Smart City Technologies and Solutions, 2012" and will reach main adoption in the next two to five years. This governance enables the structured approach between public and private investment of urban development, as well as the development of business metrics. However, metrics are slow to develop since, in many Smart City frameworks or master plans, operationally efficient infrastructure remains the key purpose rather than addressing the direct impact and value to the citizen or business.

In many ways, the process of developing of Smart City planning and business models is still trying to identify a critical set of services that cities can offer citizens. Nevertheless, innovation in Smart Cities will come from the ownership and the aggregation of the information, as well as the context and linkages around it. Driving some of the revenue-bearing, information-based application environments are communications service providers and IT service providers that are building ecosystem approaches with new partner vendors, such as the flinc car-sharing application and the SeeClickFix incident reporting application, to develop innovative approaches using the new information exchange environment in cities.

New partners harnessing information will be social media and over-the-top players, such as Google. For end-user organizations, the benefit in adopting different services and applications based on the information environment can be immense, but the ecosystems and the interoperability between different providers is not yet established. Therefore, selective applications might be available, such as an M2M-implemented logistics or asset tracking system that can also provide vehicle and driver statistics. However, electric fleet management is not available yet across a variety of providers.

Risks

The biggest risk is the large investment cycles of Smart Cities and urban regions when Smart City planning initiatives are being orchestrated and governed solely by the city. In many cases, it takes a long time to develop a consensus plan to get the different private and public stakeholders to agree on a master plan for their city. In addition, the regulatory environment around data aggregation and information exchange — especially for contextualized and linked information — is not yet fully settled.

Instead, many cities start their investments on a project basis, which is integrated in a master plan but can be executed in a more transparent way. Cities with economic challenges start to curb operating expenses by implementing LED lights in public lighting (see “Case Study: San Jose’s Intelligent Streetlight Program”). They also implement building management systems to reduce energy consumption in public buildings. Examples include the following:

- Singapore focuses on traffic management and energy reductions as key initiatives, fostering investment in this area.
- To curb risks for Japanese vendors, the national government in Japan (through the Ministry of Economy, Trade and Industry) is investing \$4.5 billion in international markets to support the development of Smart City and the opportunity for Japanese vendors.
- In the 12th Five-Year plan, the Chinese government implemented the mandate to create Smart City strategies for all major cities in China (see “IT Strategy Implications From China’s 12th Five- Year Plan”).

- The Central Electricity Authority in India developed a five-year plan on energy, which will massively impact energy distribution in urban corridors.

So, while there is a national push, there is no “silver bullet” on Smart City business revenue yet. This also means that the development of sustained Smart City value will be derived with the individual goals of the city’s main drivers in mind, and not as a common set of principles applicable throughout all cities universally. Based on the layer approach of a Smart City topology, there is a wide pool of vendors to be aware of (see Table 1). In nearly all Smart City deployments today, as well as master plans, the Smart City ecosystem contains a full range of OT, IT and middleware vendors.

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