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A Nation of Smart Cities

An Industry Discussion White Paper

India has recently committed to the development and construction of 100 Smart Cities to meet the demands of its rapidly growing and urbanizing population. This effort will include construction of new municipalities and renovation of existing cities as the rural population shifts into urban areas. This white paper is a direct outgrowth of U.S.-India Business Council (USIBC) Chairman and MasterCard Global CEO Ajay Banga's mission to meet with the new Modi Administration in June. His discussion with Minister of Urban Development Venkaiah Naidu included topics such as India's growing need for jobs, housing, commercial floor space and other pressing challenges. An outcome from that meeting was a specific issue paper that would discuss Smart Cities in a robust manner and feature expertise from USIBC member companies.

This white paper discusses the building of Smart Cities and establishing a sustainable economy as well as healthy communities in response to Minister Naidu's request. Smart Cities are the integration of information technology, telecommunications, urban planning, smart infrastructure and operations in an environment geared to maximize the quality of life for a city's population. Such a coordinated approach from the inception of a metropolitan area is key to sustainable growth and development which India requires going forward. This paper highlights how synergies between the United States and India which can produce such environments, address many looming concerns and open the pathway to a new era for the Indian economy.

The contents of this paper have been drawn from USIBC member companies with specific interest in the Smart Cities concept. This group came together to explore and define basic fundamentals for such urban centers and to begin the discussion on their applicability in India. USIBC represents over 300 companies in 13 different sectors with members from both India and the U.S. giving USIBC a unique perspective on issues of importance to both countries.

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Gujarat Tec City
Source: LiveMint, 2013

Introduction

With 3.3 billion people living in cities across the globe – a number that will double by 2050 – the need for cities that can drive sustainable economic growth and prosperity has never been more apparent.

As the world's population shifts to urban areas, policymakers are pressed for answers to overcrowding, pollution, budget limitations, aging infrastructure, resource constraints and the need for continuing growth. According to research from the Massachusetts Institute of Technology (MIT), cities will account for nearly 90 percent of global population growth, 80 percent of wealth creation, and 60 percent of total energy consumption.

These issues can be mitigated through the adoption of scalable solutions that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs, and enhance quality of life. Cities that use this approach are commonly referred to as "Smart Cities", a concept highly discussed in urban planning and city policy circles worldwide.

The term Smart Cities can be broadly used to describe cities that take a holistic approach towards this goal – spanning *infrastructure*, *operations* and *people*. Driven by data, and organized around a comprehensive strategic set of goals, Smart Cities provide local administrators with the tools to make more effective decisions, proactively resolve any anticipated issues, and better coordinate

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public resources. This would entail utilizing energy and water more efficiently, preventing crime and natural disasters, reducing traffic congestion, and improving access to public services such as healthcare, infrastructure and education to residents.

With Smart Cities, city leaders from all around the world are moving beyond policy-based decisions to evidence-based decisions grounded in data. This allows breakthrough efficiency in coordinating resources, anticipating problems, integrating information and investing in the right services and infrastructure for its residents.

Recognizing that India is currently experiencing a high pace of urbanization and movement of its citizens from smaller towns and villages to cities, Finance Minister Arun Jaitley set aside 7600 Crore ($1.24 billion USD) for the creation of 100 Smart Cities in the maiden budget that the new government presented to Parliament in July 2014. This plan envisions not only the building of new cities from the ground up but also modernizing older cities.

The publication of the Concept Note on Smart Cities by the Indian Government in September 2014 provided clarity about the policy-makers' thinking underpinning public statements and commitments in the recent election about the swift creation of 100 Smart Cities in India. The concepts set out in the paper cover a broad span of public administration, economic, social and sustainability issues. In this sense it was far from unusual: the established body of knowledge on smart cities as a concept is broad and relatively shallow, and the set of projects and initiatives pursued by organizations active in this space that have been bestowed with the 'smart city' tag is heterogeneous. Projects to reduce the emissions of greenhouse gases caused by lighting systems in commercial property share the space with others concerned with the use of the internet to empower citizens and to reform democracy; and there are a host of others projects and ideas in between.

There are, however, a number of core principles that can be identified in all the body of smart city work. The aim of this paper is to set out MasterCard's understanding of those core principles and to present the capabilities that MasterCard possesses to help cities implement smart city projects in line with them.

Smart Cities: A Virtuous Cycle

A virtuous cycle links the implementation of integrated services, new business models, and government machineries which is essential to implement necessary components for Smart Cities.

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The growth of Smart Cities can be seen as a virtuous cycle as illustrated in Figure 1. The growth not only delivers unique benefits at each of the levels, but also enhances a city's ability to develop efficient services.

Improving the livability index of a city promotes it as a world-class location. This can attract and retain talent amid increasingly competitive labor markets. The growth in jobs and in talent influences the direction of foreign direct investment to further enrich the business environment.

Figure 1. Smart Cities' Virtuous Cycle
Source: Cisco, 2013

In this paper, we provide a structured view of key elements of a Smart City, and conclude with a perspective specific to India.

Understanding Smart Cities

Cities are built on the three pillars of *Infrastructure*, *Operations* and *People*. In a Smart City, not only is each one of these pillars infused with intelligence, but more importantly the pillars work in an interconnected and integrated fashion to utilize resources efficiently.

For example, a Smart City's power distribution infrastructure will be built on Smart Grid technologies, which will integrate with local power demand patterns, grid supply variations, and a well-defined operational process – to manage the available energy most efficiently. A Smart City will integrate energy needs across the board – from home consumers (starting from more energy

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efficient investment in their own homes) to powering city-wide infrastructure such as lights to ensuring reliable supply of energy for manufacturing jobs. This is accomplished through the use of data to predict energy trends and to compensate through redirection of energy and use of efficient materials to reduce demand.

Whatever the focus of a smart city project, it is likely that it can be characterized by its adherence to the following principles:

A smart city strives to deliver services remotely over networks. Cities embracing the smart city philosophy aspire to move the vast majority of their processes for engaging with and delivering content or services to citizens online, such that the interaction between the citizen and the public authority is carried out on a connected device. The aim here is to extend the reach of service delivery beyond the confines of government premises and beyond the restrictions of the normal working day for public administration employees.

It is designed to automate and integrate to achieve clarity of view. Many city managers and representatives recognize that the traditional method of delegation of delivery responsibilities to individual departments or agencies meant that no-one can obtain a clear view of the holistic "state of the city". Smart city thinking seeks to change this by opening up channels by which distinct parts of the city's administration can share data and insights. It also includes taking steps to make the fabric of the city itself part of the system, by including the capability to automatically report status and other useful information in physical devices deployed on the streets. Roads, street-lights, traffic-lights and other devices like this become valuable new sources of real-time, automated data that can be used to enhance the picture of what is happening "right-now" in the city.

A smart city strives to personalize its interactions with each individual. Citizens differ widely in their circumstances and preferences. Smart cities recognize this and strive to use data to ensure that their interactions with citizens take account of individual circumstances and preferences where these are known.

A smart city strives to optimize operations in real-time to maximize efficiency. The application of modern analysis and processing techniques to the streams of data flowing around a city offers the prospect of using predictive techniques to intervene in the functioning of a city to prevent problems and to improve efficiency. Early intervention in the flow of traffic on a motorway early in the

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afternoon – for example by activating traffic signal controls on entry ramps or temporarily elevating prices in the city's road-user charging scheme – can mitigate the build-up of congestion in late afternoon in the city center. It is only now that predictive analytic techniques are becoming sufficiently sophisticated to be able to design reliable interventions 'on the fly' that decision-makers can implement in advance of problems to prevent them happening.

IBM's Journal of Research & Development in 2010 offered the following definition of a smart city: "an instrumented, interconnected and intelligent city". That seems in MasterCard's view to get to the heart of the concept.

In other words, in a Smart City the whole is greater than the sum of its parts.

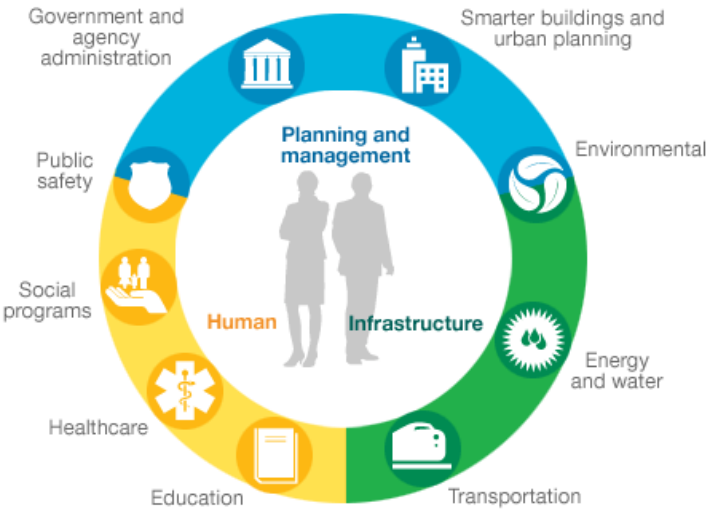

Figure 2: Components of a Smart City
Source: IBM, 2014

The capabilities and solutions deployed in a typical Smart City can be categorized as follows:

Infrastructure

City leaders must provide the fundamental infrastructure to deliver services such as water, energy, telecommunications and transportation while making the city a desirable place through the intelligent application of Information and Communication Technology (ICT).

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The fundamental concept of a Smart City is the seamless integration of physical infrastructure, such as fiber optics, to the digital infrastructure. Figure 2 illustrates the vision of the future city, a city with a pervasive overlay of ICT connecting things, organizations, and people. For example, imagine having sensors in cars connected to transportation management systems that analyze day-to-day traffic flow data that will provide drivers with better routes to their destinations and provide public safety officials with quicker routes to improve response times.

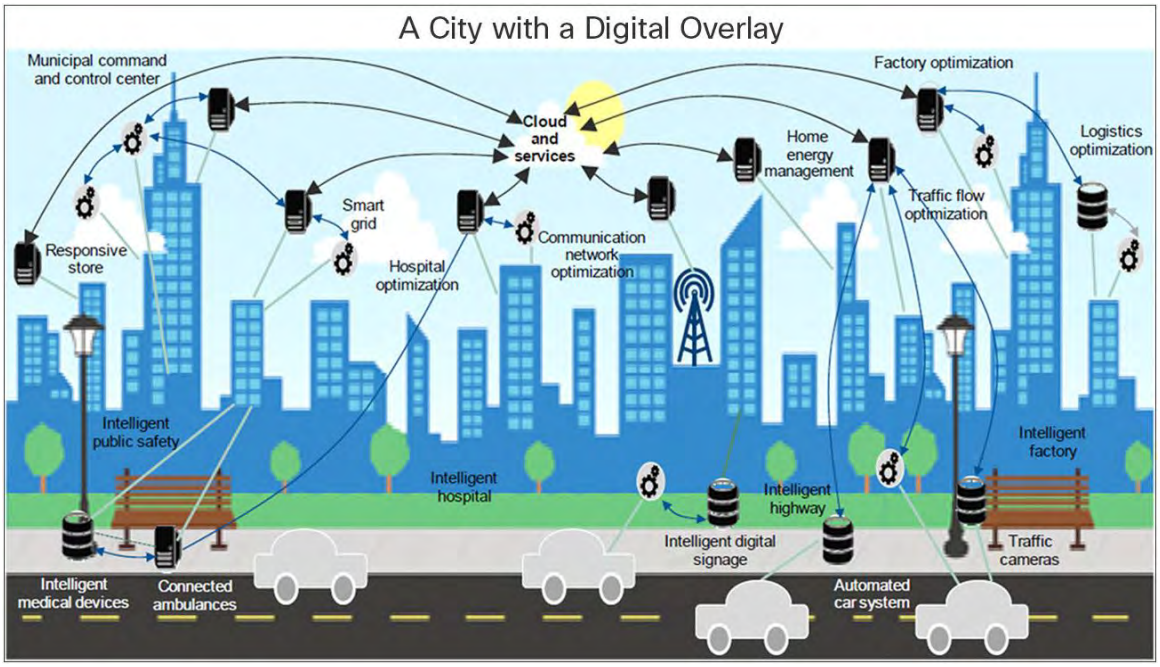

Figure 3: Vision of the Future City
Source: IDC Government Insights, 2013

Energy and Water solutions

Smart grids or intelligent utility networks

Smart Grids alleviate problems such as reducing outages and faults, improving responsiveness of utility companies to handle demand variations, increasing efficiencies by reducing transmission & distribution losses, and managing costs better. More importantly, they allow customers to participate in the energy value chain, by enabling more intelligence throughout the grid.

Smart Grid solutions are built on instrumentation such as smart meters, digital sensors, advanced communication networks and sophisticated analytics. By enabling intelligent flow of information, Smart Grids optimize regulation, generation, supply and consumption of electricity.

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Next generation smart grid would enable the Smart City to grow its power requirements to meet its growing energy needs. And as multiple generators from diverse energy sources (hydroelectric, fossil fuel, solar, wind, etc.) feed variable demand thru variable generators, the grid would be designed to provide for minimizing the fault-currents thru use of next generation fault-current limiters and switch-yard designs. Moreover, the potential of solar rooftop would be maximized by deploying guidelines on roof-heights and shade-limiting, individual rooftop solar harvesting opportunities.

Smart lighting

According to several surveys, Street lighting equals 40 percent of the electricity bill of municipalities. Maintenance of streetlights is an operational issue given large numbers and geographical distribution. According to the data, lighting accounts for 19 percent of all electricity consumed. One-third of the world's roads are still lighted by technology dating back to the 1960s. The installation of new street lighting solutions can save up to US$13.1 billion in energy per year.

A leading lighting company estimates that a complete switch to LED technology can generate savings of about US$179 billion - an enormous sum equivalent to the elimination of 640 medium-sized power stations globally.

Furthermore, an independent, global trial of LED technology in 12 of the world's largest cities found that LEDs can generate energy savings of 50 to 70 percent - with savings reaching 80 percent when LED lighting is coupled with smart controls. The program also indicated that citizens of pilot cities prefer LED lighting, citing the social and environmental benefits, such as a greater sense of safety and improved visibility.

A smart lighting approach helps cities manage street lighting to reduce energy and maintenance costs through a common network infrastructure. The technology includes energy efficient lights (LED or equivalent) with wireless controllers, remotely manageable streetlights and network for connectivity, light management systems, and maintenance system to view the operational status of lights.

The outcome is reduction in energy consumption on street lighting and optimization of management/maintenance process of large-scale lighting deployments.

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Policymakers can enhance the resources for a Smart Grid by simultaneously optimizing investment in energy-efficient infrastructure. Building insulation, alternative energy (solar for homes), and upgraded transmissions lines can ensure that the energy available is maximized for all available uses.

Furthermore, Smart Grids can provide superior data on the amount of energy available which can lead to better prioritization of local manufacturing investments. In areas where a higher percentage is necessary for public consumption, governments can target energy-light manufacturing. Incentivizing the appropriate type of investment will ensure that the energy grid is not overburdened, threatening the viability of investment and the jobs associated.

Intelligent water management

Water can often be one of the city's most stressed resources, where access to clean water affects economic activity, development and business. Challenges include better management of supply and distribution, preventing waste, and dealing with aging infrastructure.

Intelligent water management solutions use instrumentation (e.g. metering systems) and analytics to better manage demand and supply. For example, they can anticipate potential delivery disruption, better forecast long-term demand, and coordinate resources to protect water supply.

Furthermore, intelligent water management solutions provide insights into the utility's infrastructure, assets and operations – detecting patterns and anomalies and then acting on them. Such capabilities include pressure and leak management, flood management, sewer overflow mitigation, quality management, and work scheduling.

Most importantly, smart water management should focus on ensuring high quality resources for public consumption leveraging the appropriate technology (UV filtration, reverse osmosis membranes etc.) to meet the quality needs necessary to build healthy communities.

Additionally, intelligent water management should incorporate public-private sector cooperation on deploying technologies to support resource-smart manufacturing. Water is a necessary element of

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manufacturing – but the myriad of technologies and processes can encourage more efficient utilization from water management to recycling, to zero-waste plant designs. The Government of India should incentivize innovative technology uses for manufacturing investment and for appropriate leveraging of local water resources.

Asset lifecycle management

Infrastructure and utility companies are asset-intensive, and the productivity and uptime of these assets needs to be maintained over a long period of time. Issues such as transmission losses in an electrical network, and leaks or inefficient pumping in a water network – are examples illustrating the need for managing the lifecycle of these assets. Asset lifecycle management (ALM) solutions essentially optimize productivity of capital expenditure (capex) and operational expenditure (op-ex) for asset-intensive industries. Their capabilities include utilizing instrumentation for "condition based maintenance", managing operations and maintenance (O&M) processes spares, and coordinating resources and work on the field to optimize costs.

They typically also include capabilities of mobile workforce management – to enable real-time coordination between the field force and dispatch center.

ALM solutions are a vital part of infrastructure modernization initiatives, and revitalization of today's utilities.

Smart Waste Logistics

Recycling is considered the cornerstone of environmental stewardship. With state-of-the-art material recovery facilities, industrial composting, and new-age waste-to-energy technologies, cities can extract more value from their waste than ever before while improving general quality of life. For an intelligent waste management system to succeed, however, this means a robust network of public infrastructure systems that manages solid waste from collection to disposal. With zero landfill concepts in mind, the system could integrate material recovery through efficient recycling, organics management and composting.

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The utilization of existing technologies such as geographic and information systems (GIS), enhanced web and wireless network connectivity, mobile and handheld devices, next generation sensors and radio frequency (RF) technologies can boost logistical capabilities in collection, recycling and disposal. Additionally, there are new generations of Material Recovery Facility (MRF) models, Bio Digesters, Energy from Waste (EFW) technologies and Modern Waste-To-Energy (WTE) facilities that can further reduce environmental impact from waste while producing positive output.

Source Reduction is a critical first step toward responsible waste management is to strategically reduce overall material consumption. By considering resource dependence and recyclability during design and procurement, cities can set the groundwork for clean, efficient futures that thrive on foresight and innovation, not landfills. The circular model is an ideal concept to spur smart management of waste and resources overall.

Intelligent transit

Traffic congestion and gridlocks affect commerce, safety and the environment. Intelligent transportation solutions are designed with the purpose of reducing traffic congestion, improving incident response, optimizing traffic flow and proactively manage traffic conditions. They achieve this through live traffic monitoring, analysis and prediction capabilities, by leveraging data from disparate sources, such as IP cameras, radar and under-road loop detectors as well as systems based on Bluetooth or mobile phone technology on a common city network infrastructure. Additionally, intelligent investment in transportation infrastructure would support more sustainable and safe investment. From road bed insulation to prevent cracking from weather extremes to water-soluble (and less toxic) paints for road safety markings – technology can ensure safer and longer-lasting infrastructure.

Real-time optimization

The smart city concept offers the prospect of cities that can monitor what is happening in close to real time, and – importantly – analyze it fast enough to respond to it. Some responses can be prescriptive, and there is no doubt that major benefits will flow to even those cities that choose to limit themselves to this set of responses. By prescriptive responses we mean measures like closing

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entry ramps to motorways when congestion builds up or opening up additional parking spaces when self-reporting cars indicate there is substantial un-met demand for parking in an area.

But there are more nuanced, fine-grained approaches to real-time optimization of a city's infrastructure and services than this. Approaches that use the real-time variation of pricing – especially for urban transportation – offer the prospect of a smart city being able to balance minutely the various systemic and localized pressures on the city's infrastructure to achieve optimal utilization and the best possible experience for the people in the city at that moment. At the heart of this model is the idea of making offers to people to "nudge" them; that is to cause them to make timely changes in their plans so as to achieve the desired infrastructure utilization goal. Achieving this requires the city to have three things:

a) A way to make a financially-beneficial offer to a person on the move or about to start moving – the smartphone linked to a person's "city account" can act as a channel to reach the person and also links to a payment card through which the city can deliver a refund or incentive payment if the desired "nudge" is achieved;

b) Powerful analytics to calculate what level of "nudge" incentives might need to be offered and to how many people to achieve the total overall desired change in transportation demand – for example figuring out how many people need to be encouraged off the freeway and onto the local railway station in the event of a traffic incident blocking a city bridge; and

c) Understanding about which people might be willing to change their behavior if asked – which flows from insight about preferences at a personal level.

MasterCard's various analytics and offers platforms, which operate at global scale, can provide these capabilities to cities keen to realize this fullest manifestation of the smart city vision.

Integrated fare management

In major cities, public transportation is a key means to improve traffic and better share existing resources. To increase utilization and adoption of these systems, citizens should be able to seamlessly use payment systems associated with metro rail, parking garages, subways, buses, tolls, etc. Integrated fare management systems enable this by using a single smart card to access and pay for all their transportation needs.

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Such solutions increase public transit adoption, reducing delays and congestion, enable flexible fare policies – while providing operators with trends that can be used to optimize network and asset usage.

For international visitors the potential of cities can be realized. As payments and navigation become much easier so mobility can become less stressful and more impulsive. Less precious time is wasted in fumbling for foreign currency. Effortless payments encourage easy mobility and engender greater confidence in using public transport among visitors in particular. However, there is much more to the city experience than how we pay to travel.

Parking

As illustrated in Figure 4, parking can be a challenging issue, especially in urban areas where 30 percent of all traffic congestion is caused by drivers circling to find a space[1]. Adding to that the amount of time wasted and the limited data available to guide motorists' decision making lowers the quality of life. Cities are also losing out through the damaging environmental effects, lost revenue due to inadequate meter enforcement and no-parking, standing, and loading zone violations. Income for shops and local businesses is also heavily affected by the availability of parking.

Figure 4: Parking Challenges
Source: Cisco, 2013

Smart parking approach to city parking takes full advantage of the common network infrastructure. The technology combines IP cameras, sensors, smartphone apps, and the citywide network

[1] Smart Parking and Connected Consumer Report, Intelligent Transport Society of America, 2012

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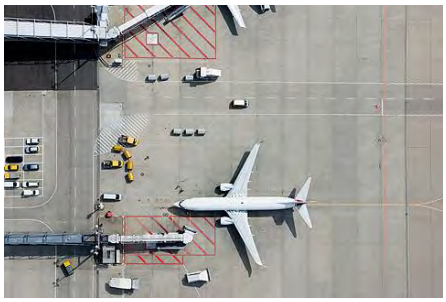
infrastructure to provide parking availability to citizens in real time. The system also provides greater visibility into parking analytics, such as usage and vacancy periods, so cities can make better informed decisions and long-term plans.

The end result is less traffic congestion and a more effective partnership between cities, citizens, local businesses, and parking enforcement agencies.

Airports



Airports are transportation nerve centers of Smart Cities. As air traffic increases, their ability to respond to dynamic situations, and managing disparate resources and information becomes critical. Airport operations management solutions enable information sharing and collaboration between multiple service providers. This enables coordinated response to situations such as resource shortages, asset downtimes, inclement weather, etc.
The solution may involve integrating multiple smaller airports, by leveraging a central airport operational database. Its capabilities include operational support across agencies, baggage and cargo management, security surveillance systems, and passenger experience solutions such as kiosks and mobile enablement for passengers.

Planning and Management

Running a Smart City is about long-term insights based on comprehensive data analysis, followed up through efficient daily management. This helps the city stay vital and safe for its citizens and businesses, and allows them to realize their full potential.

Operations

Law enforcement

Beyond the traditional "protect and serve" role, law enforcement in major cities involves reducing repeat offences, emergency management and terrorism interdiction. A Smart City enables law enforcement agencies to carry out these functions despite limited

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resources, by maximizing usage of existing data, analytics capabilities, and real-time collaboration. Such solutions allow data spread across citizen calls, case records, surveillance, and social data – to be correlated into actionable intelligence and views that allow crime prevention, instead of just crime response.

They also enable data sharing across agencies, facilitating collaboration across jurisdictions, agencies and community-based organizations.

Smart surveillance

Smart Cities extensively leverage surveillance technology to protect airports, railways, bridges and ports – from sabotage, terrorism, theft or vandalism. While surveillance plays the role of a deterrent, it needs to be combined with video analytics, additional data sources (e.g. location data from a citizen call), and processes that enable contextual retrieval and use of surveillance records. Smart Cities typically use surveillance technology in conjunction with an end-to-end safe city architecture, which ensures greater effectiveness of the captured information.

Emergency management

Smart Cities take a coordinated, cross-agency and preventive view of emergency management. Since a Smart City is an integrated system – having an end-to-end situational view across multiple agencies, systems, and regions – it is possible to achieve much more robust emergency prevention and response. Key elements of this solution include end-to-end situational awareness, Standard Operating Procedures (SOPs) across multiple agencies, and command and control. To take a preventive proactive approach, these solutions also include impact analysis and planning capabilities. For example, in case of an explosion, what is the impact radius, which critical infrastructure components will be impacted, which hospitals can provide support and other services. Preparedness plans should also engage local manufacturing and community engagement to ensure the appropriate technical

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information is available and communities understand appropriate responses to key situations. These solutions may further utilize various forms of mobile field communication technologies, backup infrastructure such as mobile command centers, etc. – to facilitate real-time command and control.

Smart buildings and urban planning solutions

Smart Buildings are an essential and defining element of Smart Cities. A Smart Building is designed to optimize usage of energy and water, and to minimize environment impact. Automation systems in such buildings provide visibility and control of their energy usage, safety and security. In addition, these buildings interact intelligently with a Smart City infrastructure such as the Smart Grid, water and waste management systems, Telecom infrastructure and other ICT enhanced services.

The enablers of the economy of the 21st century need to strongly consider buildings built to efficiency standards that greatly reduce the required renewable energy load required to drive it. Today energy demand reduction technology is far cheaper than renewable energy. By managing both you can optimize the installed cost of renewable energy by reducing demand through energy efficient technologies.

Some of the building blocks of smart building and urban planning solutions include real estate management, capital projects management, space management, facility maintenance, and energy management.

Government and agency administration solutions

A Smart City typically leverages a suite of government and agency administration solutions for its operations. These may include geographic information systems (GIS), performance management solutions, and social collaboration solutions.

In addition, some cities and local governments may optimize resources by sharing solutions using Cloud computing.

Environment

Cities are responsible for between 60 to 80 percent of world's energy and greenhouse emissions. A city's environmental conditions have a huge bearing on its livability index. Air, noise, and water

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quality sensors can help enable monitoring of key environmental metrics to better inform short-term and long-term response plans.

Cities address environmental challenges through a common network infrastructure. The approach features environmental smart sensors that report on temperature, noise, humidity, gas and dust-particle concentration, and more in real-time. The data gathered helps to describe the city's overall livability, while also helping to detect levels outside of set thresholds and trigger alerts back to the city situation room.

People

Smart Cities use the system of systems to their advantage when supporting the needs of each citizen through social programs, healthcare and education.

Social programs and healthcare

Smart Cities focus on optimizing outcomes of social programs for citizens. Social Program Management solutions are business process management solutions, which manage the end-to-end lifecycle of such programs from intake to outcome. Additionally they have capabilities for evidence and eligibility management.

Specializations of these solutions may include child welfare or medical assistance programs. Such specializations may model various government programs such as subsidized education, medical assistance and insurance models, and help automate eligibility and entitlement determination.

Education

Smart Cities must have explicit focus on quality education, since schools and higher learning institutions define a society's long term health and prosperity, educating the workers and leaders of tomorrow.

Smart education solutions are designed to optimize student performance, teacher training, helping low performing schools and school administration.

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Smart schools leverage automation and technology to capture critical data, such as attendance, grades and enrollment in activities. They also use technology to deliver digital course content through smart, interactive classrooms. Further, they use student-centric analytics solutions to get real-time perspective of student performance, and plan interventions to improve performance and employability.

Smart schools unlock further value when they are interconnected for collaboration. This allows content sharing, teacher training, sharing of scarce resources, etc. This can also be extended to parents, for example, allowing them to track academic grades and scores, attendance and comparative data online.

Such an intelligent school system can provide school administrators the tools needed to allocate resources in an effective manner.

Additionally, Smart City programs should incorporate education and engagement of high-skilled professionals creating a network of research institutions which would provide a cadre of decisions makers and intellectuals that influence the societal and governmental adoption of such new concepts.

Biometric identification

Biometrics refers to metrics related to human characteristics and traits that can be uniquely identified and measured in individuals. Physiological characteristics are related to the physical aspects of the body including, but are not limited to, fingerprints, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, and retina mapping. More traditional means of access control include token-based identification systems, such as a driver's license or passport, and knowledge-based identification systems, such as a password or personal identification number. Since biometric identifiers are unique to individuals, they are more reliable in verifying identity than token and knowledge-based methods.

India has already begun a program, called Aadhaar, which will be the largest biometric database by sheer volume of participants in the world. It is a biometrics-based digital identity assigned for lifetime, verifiable through smart services. It is designed to enable government agencies to deliver services to the public securely based on biometric data (utilizing fingerprints, iris scans and

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photographs), along with demographic data (name, age, gender, address, parent/spouse name, mobile phone number).

Healthcare

In the healthcare sector, smart systems lead to better diagnostic tools, to better treatment and quality of life for patients by simultaneously reducing costs of public healthcare systems. Key developments in this sector are smart miniaturized devices and artificial organs like artificial pancreas or cochlear implants. Patient data can be saved in a digitized system the can prevent medical errors, such as those associated with medication conflicts and previous medical history, through streamlined data sharing between physicians and other medical professionals.

For example, Lab-on-a-chip devices have biochemical sensors that detect specific molecular markers in body fluids or tissue. They can include multiple functionalities such as sample taking, sample preparation, and sample pre-treatment, data processing, and storage, implantable systems which can be reabsorbed by the body after use, non-invasive sensors based on transdermal principles, or devices for responsive administration of medication. In healthcare, smart systems often operate autonomously and within networks, because those systems are able to provide real-time monitoring, diagnosis, interaction with other devices, and communication with the patient or physician.

Wellness

A Smart City requires a multidisciplinary and trans-disciplinary approach which would include designers, builders, technology professionals, health experts, environmentalists, educators, sociologists and urban development policy experts. Creating an intelligent technology environment is important but only one aspect of the Smart City ecosystem. Building cities that capitalize on the inherent strengths of the population will be critical to the overall development of Smart Cities.

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India Perspective

India is witnessing a rapid pace of urbanization, which is expected to continue in the coming decades. According to recent studies, by 2030:

- 40% of India's population will be living in urban areas
- 68 cities will have a population of more than 1 million
- 70% of net new employment will be generated in cities

It is estimated that, on average, about 75% of the global economic production takes place in cities, and Indian urban areas will also follow the trend and account for nearly 70% of the country's GDP by 2030.

By 2020, housing shortage will reach about 30 million dwelling units, 200 million new water connections will be required, 250 million people will have to be given access to sewage, 160 GW of power generating capacity will have to be added and the number of vehicles on our urban roads will increase by 5 times.

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Leveraging Smart Cities experience and technology available worldwide, India can drive the much-needed transformation to a nation of Smart Cities.

We expect this to proceed along two streams: The first involves modernization and overhaul of existing cities, where the focus will be on developing and implementing practical solutions that can work optimally with legacy systems and infrastructure. The other stream will involve the creation of new Smart Cities from the ground up by leveraging international best practices.

In each case – as evident globally – along with requisite investment in all aspects of urban infrastructure, investment will be required in adapting ICT-enabled management systems and data-driven analytics and decision making in urban planning and operations.

As demonstrated worldwide, Smart Cities require a holistic approach targeting all three pillars of a Smart City namely *Infrastructure, Operations* and *People*. For India, Smart Cities are the need of the hour to achieve significant progress and create a thought leadership position in the global economy.

With thanks to

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