सत्यमेव जयते

TECHNICAL REPORT

M2M & ICT ENABLEMENT IN

SMART CITIES

ICT DEPLOYMENT AND STRATEGIES FOR INDIA'S SMART CITIES : A CURTAIN RAISER

TEC-TR-S&D-M2M-006-01

M2M SMART CITY WORKING GROUP

ISO 9001:2008

TELECOMMUNICATION ENGINEERING CENTRE
DEPARTMENT OF TELECOMMUNICATIONS
MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY
GOVERNMENT OF INDIA

RELEASE 1.0

NOVEMBER 2015

सत्यमेव जयते

TECHNICAL REPORT

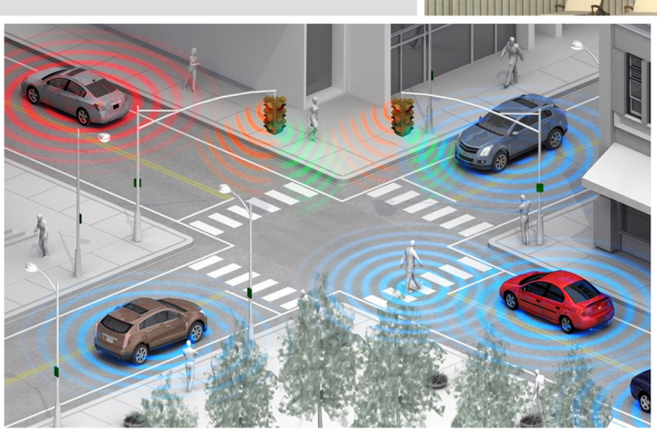
M2M & ICT ENABLEMENT IN

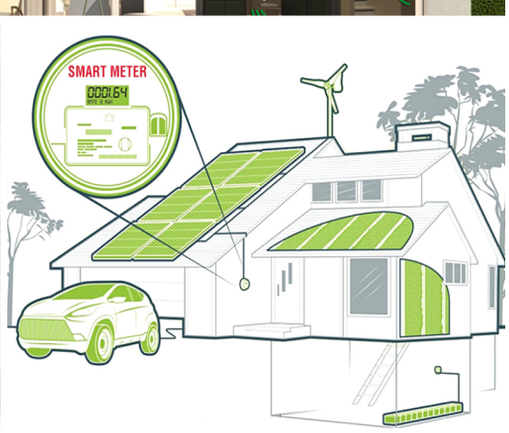
SMART CITIES

ICT DEPLOYMENT AND STRATEGIES FOR INDIA'S SMART CITIES : A CURTAIN RAISER

TEC-TR-S&D-M2M-006-01

M2M SMART CITY WORKING GROUP





ISO 9001:2008

TELECOMMUNICATION ENGINEERING CENTRE
DEPARTMENT OF TELECOMMUNICATIONS
MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY
GOVERNMENT OF INDIA

RELEASE 1.0

NOVEMBER 2015

Revision History

Date	Release	Document No.	Description
20-11-2015	R1.0	TEC-TR-S&D-M2M-006-01	ICT Deployments and Strategies for India's Smart Cities: A Curtain Raiser

Important Notice

Individual copies of the present document can be downloaded from **http://www.tec.gov.in**
Users of the present document should be aware that the document may be subject to revision or change of status.
Any comment/suggestions may please be sent to:**m2mreports.tec@gov.in**

Disclaimer

The information contained is mostly compiled from different sources and no claim is being made for being original. Every care has been taken to provide the correct and up to date information along with references thereof. However, neither TEC nor the authors shall be liable for any loss or damage whatsoever, including incidental or consequential loss or damage, arising out of, or in connection with any use of or reliance on the information in this document. In case of any doubt or query, readers are requested to refer to the detailed relevant documents.

Contents

List of Contributors

A. Joint Working Group (JWG) Chairman:

Name	Designation	Organisation	E-mail Address
A. K. Mittal	Sr. DDG	Telecommunication Engineering Centre (TEC)	srddg.tec@gov.in

B. Joint Working Group (JWG) Secretariat:

Name	Designation	Organisation	E-mail Address
Sushil Kumar	DDG (S&D)	Telecommunication Engineering Centre (TEC)	ddgsd.tec@gov.in

C. Working Group (WG) Chairs:

	Name	Designation	Organisation	E-mail Address
Chairman	Bipin Pradeep Kumar	Founder and Director	Gaia Smart Cities	Bipin.kumar@gaiasmartcities.com
Vice-Chairman	Sai Pratyush	Additional Vice President	TTSL	sai.pratyush@tatatel.co.in
Rapporteur	RaunaqueQuaiser	Senior Manager	STMicroelectronics	raunaque.quaiser@st.com
Co-Rapporteur	Rajeev Tyagi	Dir (S&D-I)	Telecom Engineering Centre	dirsd1.tec@gov.in

D. Primary Authors:

Name	Organisation
Bipin Pradeep Kumar	Gaia Smart Cities
RaunaqueMujeebQuaiser	STMicroelectronics

E. Contributors:

S.No.	Name	Organisation
1.	A.K.Mittal	TEC
2.	Sushil Kumar	TEC
3.	Pamela Kumar	CCICI
4.	Aastha Sayal	Gaia Smart Cities
5.	Ratan J. Batliboi	RJB-CPL
6.	Bindoo Srivastav	Smart Electrons
7.	Sharad Arora	Sensorise India Pvt Ltd.
8.	Alok Sethi	DIMTS
9.	Ranjani Balasubramanian	RJB-CPL
10.	Geetha Manjunath	Xerox Research
11.	Pallab Saha	Wipro
12.	Ignesius Thambyraj	
13.	Surender Gupta	TCS
14.	Dinesh Chand Sharma	SESEI (CEN, CENELEC, ETSI, EC & EFTA)

15.	Kanaka Thakker	RJB-CPL
16.	Narang N Kishor	Narnix Techno Labs Pvt. Ltd.
17.	Hem P Thukral	ISGF
18.	Srinivasan Ramakrishnan	
19.	Anuj Ashokan	TTL

F. Editorial Group:

S.No.	Name	Organisation
1.	A.K.Mittal	TEC
2.	Sushil Kumar	TEC
3.	Bipin Kumar	Gaia Smart Cities
4.	RaunaqueQuaiser	STMicroelectronics
5.	Dinesh Chand Sharma	SESEI (CEN, CENELEC, ETSI, EC & EFTA)
6.	Pamela Kumar	CCICI

Executive Summary

As cities in India gear up and draw plans for the honourable PM's 100 Smart Cities program, this report on ICT Guidelines for Smart Cities is an accompaniment to the Smart City Mission Guidelines document released by the Ministry of Urban Development[1]. It attempts to draw attention to and outline a set of guidelines and frameworks for ICT for Smart Cities. It focuses on ICT's role in Smartness and how to truly achieve Smartness with the effective use of a rapidly evolving ICT. While there are several efforts by different institutions in the Smart City arena, this collaborative government-academia-industry-societal effort organised by TEC, DOT is solely focussed on the ICT needs and approaches of Smart Cities. Its singular aim is to harmonise and orchestrate an ICT framework for the future of India's Cities.

The concept of 'Smart' and 'Sustainable' City varies among cities and around the globe. There is No '1 solutions' fitting All. Requirements of different cities may depend upon local factors and its objectives, but a sustainable Smart City should have forms of Smart communication/ ICT infrastructure, Smart mobility, Smart Living, Smart Economy, Smart Environment, Smart governance and Smart Citizens. It is also not about technology providers offering solutions, but integrating solutions, proving interoperability and cohesion among systems within a city in full collaboration with all stakeholders involved. Around the world there are examples of Smart Cities emerging and many countries have developed plans for facilitating these.

A city is a complex system of systems, involving many different domains, infrastructures, organizations and activities: all of these needs to be integrated and work together effectively for that city to become smart. This integration needs to take place at many levels, technical level of course, but also about integration of business processes and management, integrated strategies and regulations. It is clearly impossible to develop a single model of a smart city that will be simple enough, but will be comprehensive enough to cover all the key aspects. We therefore need a variety of models, each aiming to capture a key overview into the smart city and related to specific stakeholders with specific requirements. What is important is that there is a basic consistency between each of these. In other words, all of the models need to link together in some way.

Standardisation forms a critical part of the evolution that cities and communities need to make over the coming years. Being smart cities 'systems of systems', a new holistic and cross functional standardization approach is needed, breaking the old 'vertical silos' approach (standards for individual sector), through better cooperation and synergies. By underpinning common understanding among all actors involved; enabling integration between systems, and between the physical and the digital; by accelerating smart city solutions and provide confidence in the market, standards will facilitate the sustainable development of ''smarter' cities, in response to final beneficiaries' needs of citizens and cities.

However, as ICT has been recognised as the true enabler of the smartness in every aspect of the smart city paradigm, it is rightly considered as a horizontal layer in the smart city framework rather than one of the pillars.

There is a need of consensus among city administration, consulting companies, service companies and technology companies on what he ICT components are necessary and how cities should approach this agenda. The smart technologies (ICT) market also suffers from a number of barriers

[1] http://smartcities.gov.in/writereaddata/SmartCityGuidelines.pdf

(interoperability, technical and institutional) that need to be overcome if the market is to grow and mature. Smart technologies or City scale ICT is part of a new and emerging market where many of the products and services are being developed.

This report and the efforts by the Smart City group seek to address these issues. While it is mostly strategic, the 7 areas the efforts are focussed on and the foundational architecture and constituent systems it highlights are critical ICT pillars of Smart Cities. In them, it outlines their context and need, at the same time impressing their importance and calling to attention the diligent studies needed in each of those specific areas.

This report provides an overall view on the foundational ICT required by Indian Smart Cities that can facilitate the Smart applications and verticals outlined above. In particular, it ascribes to outline collaborative efforts with all other working group of TEC by the Smart City group that strives to broadly depict areas within Information and Communications Technologies (ICT) that can help cities become interoperable and coherent, more sustainable and efficient, improve governance structures and bring in more autonomy in systems and services thereby improving the overall quality of life of its citizens.

1. Introduction

Urban areas are getting more and more congested due to people's migration, natural population growth, environmental changes, and local and national policies. At the same time, rapid urbanization puts pressure on resources, increasing demand for energy, water, and sanitation, as well as for public services, education and health care. Cities are therefore referred to as the engines of economic growth. There is accordingly a desperate need for the cities to get smarter to handle this large-scale urbanization and to find new ways to manage complexity, increase efficiency, reduce cost, and improve quality of life.

In the last 50 years, world population has grown exponentially at an average rate of 1.2% per year and more people are moving to cities every day. As the global population continues to grow at a steady pace, more and more people are moving to cities every single day. In 2007, for the first time in the history of mankind, the number of people living in cities surpassed the number living in rural areas and it is estimated that the proportion will exceed 70% by 2050. Given the socioeconomic development, urbanization provides better job opportunities for millions of people around the world. During 1950-2010, a net 1.3 billion people were added in small cities, more than double the number of people added in medium cities (632 million) or large cities (570 million). As per UN World Economic and Social Survey 2013[1], 80% of the world's urban population will live in developing regions, especially in cities of Africa and Asia. In India, the urban population is currently 31% of the total population and it contributes over 60% of India's GDP. It is projected that urban India will contribute nearly 75% of the national GDP in the next 15 years. Cities are accordingly referred to as the engines of economic growth.

It is pertinent to note that several forward looking nations have embarked upon their own standardization initiatives, national or regional strategy, and commercial solutions on Smart Cities or its revolving areas. This includes the European Union, United Kingdom, United States of America, China, Korea and Germany. Such an effort is critical for India considering its diverse and unique needs, and the opportunities it demands in its approach towards Smart Cities.

While, ITU defines a Smart Sustainable City as "A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects".

Recently ITU has established a new ITU-T Study Group 20 (SG 20) to address the standardization requirement of Internet of Things (IoT) technologies, with an initial focus on IoT and its applications in smart cities. On the same lines, TEC has also created a National Working Group 20 (NWG-20) to study the Indian requirement and harmonize with the global standards and submit contributions.

It can be rightly argued that there will be many requirements and needs for Smart Cities that go well beyond ICT or do not involve technology at all. However, the increased prevalence of ICT in so many areas of everyday life means that even in non ICT spheres or domains that are not specifically ICT-centred, there are aspects that are ICT-influenced or made more effective by the introduction of ICT. This prevalence of ICT is what ultimately could help transform a city into a smart city.

1.1 Temporal significance

As this report is composed and presented in November 2015, it is the second stage – the challenge round of the Smart City competition, where cities are preparing their Smart City Plan(SCP). The criteria for evaluation of this stage of competition accords a weight age of 30 out of 100 marks for implementation framework including feasibility and cost effectiveness, 20 for result orientation, 16 for citizen consultation for identifying goals, 10 for smartness of solutions, 10 for adoption of SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis for preparation of strategic plan and 5 each for city vision and quality of city profiling including identification of key performance indicators (KPIs), potential for improvement of city and 4 per cent for processes followed

Of this, implementation framework & cost effectiveness (30 marks), as well as result orientation (20 marks) and processes followed (4 marks) can be effectively monitored through ICT; citizen consultation (16 marks) can be efficiently achieved through social tools and online mechanisms, again ICT. The smartness of solutions (10 marks) would inherently require ICT. Consequently of the 100 marks, 80 marks are assigned to functions where ICT can play a play a significant to assistive role. It goes without saying that understanding how this can be achieved and enhanced using ICT in a simple, unified manner is crucial to the overall character of a Smart City.

Additionally, as each Smart City plan gets drafted, it is prudent to note that there are many cities in a state in the Smart City race. There is an opportunity for the different Smart Cities in a State to leverage State level ICT Infrastructure instead of replicating ICT infrastructure, solutions and service across multiple instances. Among other benefits, this will:

a. Ensure common services throughout the state at a minimal difference
b. Ensure sharing of resources
c. Reduce the financial burden and improve cost considerations

1.2 Spatial significance

India is very different from other developed nations in both its deployment and of consumption of ICT. Unlike in the former where there is prevalence of computers, large segments of India moved straight to mobile for information, communication and computing. The foundations of ICT are tied to Internet availability or some form of connectivity and mobile telephony. In rural India, the former is synonymous with an effort – Bharat Broadband (BharatNet) and its operation of National Optic Fiber Network (NOFN), which aims to provide 100 Mbps Broadband connectivity to the 2,50,000 Gram Panchayats in the country

According to data released by TRAI, wireless (mobile) subscriber base stood at 988.69 million at the end of Aug 15. Of this, users in urban areas stood at 570.33 million subscribers and in rural areas at 418.36 million at the end of Aug 15[2]. Looking at it from wireless tele-density in urban and rural, the former was at 145.67 and the latter at 48.09 in the month of Aug-15. Such information could be used appropriately, for example: this makes it imperative that government and public services be

[2]http://www.trai.gov.in/WriteReadData/PressRealease/Document/PR-TSD-Aug-14102015.pdf

made Smart for engagement and providing real time access to the citizens through mobile apps or other means on mobile phones.

In a much-cited study in 2005, Leonard Waverman of the London Business School found that an extra ten mobile phones per 100 people in a typical developing country added 0.6 percentage points of growth in GDP per person[3]. In another, Deloitte research cites a World Bank study in developing economies that shows that a 10% increase in broadband penetration increases per capita GDP growth by 1.3%[4]. ICT and what it brings to the forefront is crucial to India's economic and social growth.

[3]http://www.economist.com/node/14483872

[4]http://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-broadband-noexp.pdf

2. Purpose and Scope

2.1 Purpose of the document

The purpose of this document is to draw attention to the ICT standardisation and harmonisation activities for Smart Cities in India. This document is an initial primer on the needs of such an effort and the objectives set forth by the government-academic-industry Workgroup created at TEC towards this effort. It is meant to complement the Smart City mission of the MoUD by solely focusing on the ICT aspects.

This documents gives guidance on an ICT framework for decision-makers and its associated communities (the public, private, academic and voluntary sectors) to develop, agree and deliver smart city strategies that can transform their cities' ability to meet future challenges and deliver future aspirations. It describes the efforts of the Smart City group at TEC and what can be expected from it in these areas leading to Q2 2016.

. It can also be helpful to leaders of organizations and institutions involved in city-scale solutions– including both smaller urban areas and larger, regional-scale initiatives. As such, the prime intended audience includes:

- policy developers in city authorities, including:
    - those responsible for the authority's service design, commissioning and delivery role, and
    - those responsible for its community leadership role, in particular:
    - senior executives of other public bodies with a urban local body or city-wide remit;
- other stakeholders interested in leading and shaping the city environment, including:
    - organisations in the private sector who wish to partner with and assist cities in transformation of city systems to create shared value;
    - leaders from the voluntary sector organizations active within the city;
    - leaders in the higher and further educations sectors;
    - Community innovators and representatives.

2.2 Scope of the initial effort

The Smart Cities Mission Guidelines provide an illustrative list of Smart Solutions, which is illustrated in the figure 1 below. While this is not an exhaustive list, cities are free to add more applications.

Source: [13] **Figure 1 : SMART SOLUTIONS**

The efforts of Working Group addresses this; it distils current ICT practices and orchestrates new systems into a set of consistent and repeatable patterns that city leaders can use to help develop and deliver their own smart city strategies. These efforts by the Smart City group and the documents it aims to produce do not intend to describe a one-size-fits-all model for the future of Indian cities. Rather, the focus is on enabling processes and laying a set of guidelines by which innovative use of technology and data coupled with organizational and administrative impetus can help deliver the diverse visions for future Indian cities in more efficient, effective and sustainable ways.

It is understood that it is necessary for Smart Cities to have a wide range of technologies across platforms and industries capable of working together to deliver complex systems and solutions. Consequently, Smart cities need robust and resilient technologies that:

- Facilitate heterogeneous ICT-systems by different vendors to work together
- Allow for greater automation that can enable city functions to be delivered reliably and transparently.
- Facilitate instrumentation through the use of multiple types of device for sensing, capturing, storing, and exploiting the use of data from multiple sources, fixed as well as mobile;
- Make data exchange fluid and rapid between different types of network topology and using different types of communication and transmission;
- Facilitate the use and aggregation of data by systems and services that may not have initially generated them;

- Allow for data to be presented in a variety of formats, dependent on the context and the person or technical system needing it, allowing it to be analysed, visualised, accessed, and acted upon more easily, thus making it much more useful

This report brings together and binds the Smart City relevant works of other vertical sector groups established at TEC. Many of the use cases and approaches in the different smart city verticals are addressed within specific these groups at TEC (Automotive, Power, Health, Safety and Surveillance and M2M Gateway & Architecture).

The works of these vertical groups and the organisation of the Smart City group is very much on the issues and challenges involved in joining all of these up into a whole-city approach. Central to the Smart City group is therefore a strong emphasis on interoperability, business model innovation, and the active role played by all stakeholders in the creation, delivery and use of city spaces and services.

3. Characteristics and Aspirations of ICT

The Ministry of Urban Development, Government of India has outlined certain visions and objectives of Smart Cities. In order to enable this to happen, a number of key characteristics are required:

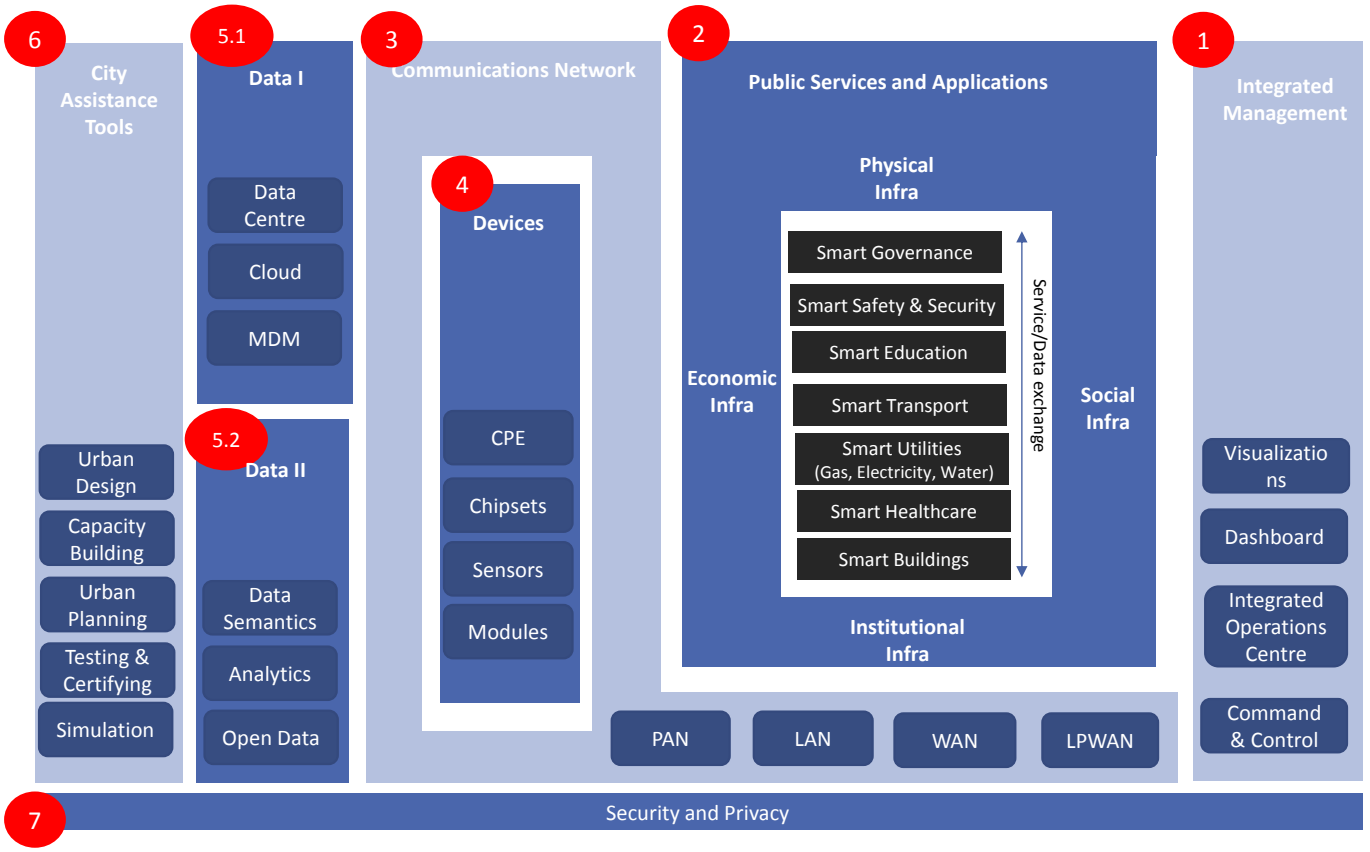
i. The city will be fitted with instruments and data aggregation mechanisms that allow the collection of increasing amounts of data about city life.
ii. These sensors, actuators, cameras and other instruments and aggregation systems will need to transfer data to and receive commands from back-end systems
iii. The data from different sources and city systems has to be available and be easily aggregated together to gain far greater insight into what is going on in the city.
iv. Detailed, measureable, real-time knowledge about the city will therefore be available at every level, so that it can be easily accessed by whichever person or technical system would be able use it to help fulfil their role or achieve their goals, within the context of the overall effective functioning of the city.
v. In addition, analytics and decision-making systems will be used, so that this knowledge can be used effectively, both by city managers and planners, and by the citizen, to support real time decision making and enable effective actions to be identified that will enable future requirements to be met.
vi. The city will also be automated, to enable appropriate city functions to be delivered transparently, reliably, and effectively, without the need of direct human intervention usually notifying the relevant authorities, unless the need arises.
vii. The continual interaction between the physical and digital worlds enables the decision making processes to be much more open and inclusive, so that citizens, policy makers and businesses can work together effectively to manage the life of the city for the benefit of all.
viii. All this needs careful attention to planning using new urban design models and tools in conjunction with evolved urban planning models and tools;
ix. There needs to be capacity building and training to efficiently manage, use and operate these new systems; and
x. Finally it needs simulation, testing and certification frameworks to implement the computational and communication systems to enable all this.

ICT plays a crucial role in each of these. The initial efforts undertaken by the Smart City group is aimed at addressing these issues.

4. ICT pillars of a Smart City

With the characteristics and purpose of ICT as the underlying guiding principles, the Working group identified the different technologies and systems that are involved in the Smart City construct. This was used to determine the main methods and means in which each of the functions in cities can be made smarter and the systems and technologies then organised as foundational areas in a structured manner.

This document identifies and recommends 7 areas as ICT foundational pillars for a Smart City. These are depicted in Figure 2 below.



Source: GAIA, Xerox and TSDSI **Figure 2: ICT PILLARS OF A SMART CITY**

4.1 Integrated Management and Command Centre

- This will provide a single interface to view all integrated city level information. These Command Centres do not imply that only one will be applicable to a city, but many smaller ones could feed requisite information along its various nodes

4.2 Services and Applications across various verticals

- These have been classified according to the Infrastructure segments identified by the MoUD. It covers vertical solutions or applications around and are not restricted to:
    i. Smart Mobility – ITS, Vehicle telematics, Insurance, Fleet management, Connected cars,
    ii. Smart Healthcare,
    iii. Smart Living - Home automation,
    iv. Smart Utilities
    v. Smart Governance - the software and solutions that can be used by the various departments for Smart Governance
    vi. Smart Manufacturing - Predictive Maintenance,
- A more detailed listing of application and services across verticals is provided in Annexure I

4.3 Communications Network

- Communication Networking technologies provide the infrastructure of the smart cities to make all the devices, computers and people have convenient, reliable, secretive communication paths with each other. This includes
    i. wired network
    ii. wireless networks,
    iii. satellite networks,
    iv. transmission protocols (MQTT), M2M connectivity;
    v. Networks that can be called MAN, WAN, PAN, HAN.
    vi. Dedicated resources that could be allocated for critical communication or communication during emergencies or disasters.

4.4 Devices and Chipsets

- Devices are an immense area and comprise a larger umbrella of routers, computers and other networking equipment. For narrowing focus and since M2M is a tenet this study revolves around, this document focuses on Sensors, RFID tags, Chipsets, Mobile devices, Embedded software, etc. that facilitate the 'sensor web' in cities
- Devices need to be compliant with IPv6 addressing.

4.5 Data

4.5.1 Data Centre, Cloud, Analytics and Backend Platform Infrastructure:

Cloud computing is the delivery of computing or storage as a service rather than a product, whereby shared resources, software, and information are provided over a network (typically the Internet). Enabling access to a common group of fundamental application services on a cloud infrastructure enables different city applications to leverage and build on the value provided by each other.

i. M2M platforms,

ii. Service enablement solutions, Application services and Device management software,
iii. Big data platforms
iv. Hybrid Cloud Infrastructure
v. Data As A Service

4.5.2 Open Data and Analytics:

One of the key enablers for Smart City applications is analytics over data to derive new insights that can be used for making smart decisions that change the life of people. The analytics can range from understanding the current state of a system better (example: Water usage), predicting a future value of interest, do a root-cause analysis of an event (example: traffic situation) or even perform what-if-analysis for different parameters. Enabling appropriate data sharing protocols, standards and schema that enables such building of analytics application would also be of interest. Machine learning and other statistical analysis of data for developing predictive models over data that can reused across different applications may also be interesting to pursue.

i. Analytics necessary to derive intelligence and implement it
ii. Statistical Analysis libraries
iii. Data Sharing protocols and best practices

4.6 City Assistance tools

- These are ICT models and tools that are aimed complementing the Smartness of Cities:
  i. Urban Design models and tools
  ii. City Simulation
  iii. Capacity Building Models and tools
  iv. Testing and Certification

4.7 Information and Digital Security

- Security of Smart City is a very large area and as illustrated in the diagram touches every aspect – the devices themselves, the communications part, the data part, the application part and the storage and services part. Besides information security, security as a topic also encompasses privacy of data and physical security. This section briefly addresses the illegal access to information and attacks causing physical disruptions in service availability in a Smart City.

5. Smart City Standardization by other Nations

The following table gives an overview of the major standardization initiatives as a national or regional strategy on Smart Cities.

This does not take into account efforts by international standardization bodies like CEN/CENELEC, ETSI, IEEE, 3GPP and OneM2M all of which have considerable initiatives in the context of the standards work for Smart Cities or areas related to it.

S No,	Nation/Effort	Description and Fields related to Smart Cities
1	European Commission	1. Launched a Smart Cities and Communities European Innovation Partnership (SCC) the European Commission that aims to boost the development of smart technologies in cities. Standardisation is one of the 11 areas of work that is being undertaken 2. EU‟s Seventh Framework Programme for Research(FP7) will invest €4.8 billion in thematic areas, with specific priorities in areas that include developing Smart Cities.
2	USA(NIST & ANSI)	1. Created Framework and Roadmap for Smart Grid Interoperability 2. Launched Draft Cyber-Physical Systems Framework 3. Launched a Global City Teams Challenge 4. Convened a Joint Member Forumin contributing to national and international Smart City initiatives.
3	UK (BSI)	Developing a standards strategy for Smart Cities. Several documents released or releasing including • BSI PAS180 Smart cities – Vocabulary • BSI PAS 181 Smart city framework – Guide to establishing strategies for smart cities and communities • BSI PAS 182 Smart City Data Concept Model • BSI PD 8100 on Smart City Overview – a guide for city managers • BSI PD 8101 Smart cities – Guide to the role of the planning and development process • BS 8904 Guidance for community sustainable development provides a decision-making framework that will help setting objectives in response to the needs and aspirations of city stakeholders • BS 11000 Collaborative relationship management
4	China	Several national standardization committees and consortia have started standardization work on Smart Cities, including: • China National IT Standardization TC (NITS), • China National CT Standardization TC, • China National Intelligent Transportation System Standardization TC, • China National TC on Digital Technique of Intelligent Building and Residence Community of Standardization Administration,

		• China Strategic Alliance of Smart City Industrial Technology Innovation
5	Korea	Standardization of ICT infrastructure, processes and governance norms that leads to the creation of an extensive information-led ecosystem which can deliver uniform citizen and business services. Set up U-City projects that will have an intrinsic lifecycle management process aligned to changing business and citizen requirements, thereby driving sustained competitive edge
6	Germany	Member of European Innovation Partnership (EIP) for Smart Cities and Communities. DKE (German Commission for Electrical, Electronic & Information Technologies) and DIN (GermanInstitute for Standardization) have developed a joint roadmap and Smart Cities recommendations for action in Germany.
7	Poland	A coordination group on Smart and Sustainable Cities and Communities (SSCC) was set up in the beginning of 2014 to monitor any national standardization activities. It has two thematic groups; one on terminology and links with the technical bodies in PKN, the other for the development of a wok programme
8	Spain	AENOR is running a standards programme made of 13 projects. These standards will promote smart cities in Spain and publications are expected during 2015-2016. A report has been published in July 2014 a report that includes the National standardization strategy for smartcities.

Table 1 - Standardisation activities in Smart Cities by other nations

Work by International Standards Organisations

- A new ISO standard on Global City Indicators has been agreed, along with three sets of other ISO standards on SSCC (smart infrastructure, management, terminology) to be proposed in 2015.
- The ISO advisory group on smart and sustainable cities, which was set up in June 2014 to advise ISO/TMB for coordinating ISO internal works, and with external initiatives.
- ISO/IEC Joint Technical Committee 1 set up a Smart Cities Study group and this has recently put together its recommendations for work on ICT standards
- IEC (The International Electrotechnical Commission) has set up a System Evaluation Group (SEG 1) to evaluate whether a Systems Committee needs to be set up to cover standards for smart cities.
- An ITU (International Telecommunications Union) Focus Group on smart and sustainable cities has been developing technical reports to help identify the standardization requirements in this area.

Relevant work by other international organisations

- **The UNEP initiatives,** GIREC (Global initiative for resource efficient cities) , SBCI (Sustainable building construction initiative), MAC (Multi stakeholders advisory committee of the 10 YFP (10 years frame work programme) …

- **A World Council on City Data,** created by GCIF in 2014 to implement and test the ISO standard 37120 on city global indicators
- **The City Protocol Society: a cross-sector but city–led NGO** that is developing common approaches to tackle city needs with a variety of experts of the City protocol task force to tackle challenges identified by cities through the implementation of projects or policies**.**

6.Use Cases for Smart Cities from other M2M groups at TEC

These application level use cases are derived from the efforts of other working groups of M2M domain at TEC that are conducive to Smart Cities.

6.1 Vertical: Intelligent Transport System

Summary:

a. Use-cases related to Public Safety
b. Use-cases related for Traffic Management
c. Use case for Commuter
d. Use-cases related Fleet Managers
e. Use case for Original Equipment Manufacturers
f. Use case related to Smart Infrastructure

S. No.	Use case title	Brief description
1	Use-cases related toPublic Safety	This is a very important use case category, which will enhance the public security and emergency management system in India. A typical call flow has been shown figure 12. M2M technology will enable police emergency VAN to respond to citizen's panic calls efficiently and will reduce the response time.
2	Use-cases for Traffic Planners /Management	Traffic management system integrates various subsystems (CCTV, GPS data, vehicle detection, messaging, digital signage etc.) into a coherent single interface that provides real time data on traffic status and predicts traffic congestions for more efficient planning and operations. Dynamic traffic control systems, freeway operations management system, incident response systems, etc. respond inreal time to changing conditions
3	Use case for Commuter	End user are the one who will utilise the benefits of Smart Cities. The ITS talks of electronics on personal vehicles such as GPS, V2V technologies
4	Use-cases related to Fleet Managers	Fleet Management is another use case that contributes to the Smart Cities and aid in reducing crimes
5	Use case for Original Equipment Manufacturers	OEM can provide services such as stolen vehicle tracking and location based anti-theft applications. The OEMs can even monitor on field performance of the product after launch. Technology enables the vehicle manufactures to provide VAS services and create new stream of revenue.
6	Use case related to Smart Infrastructure	The Smart Infrastructure is important ingredient to have a successful Smart Cities. Some of the requirements of Smart Infrastructures are Smart Parking , Toll Collection , Smart Signals, Smart roads are some of the key contributors for this use-case

Table 2 –Transportation Use Cases

6.2 Vertical: Remote Health Monitoring System

Summary:

a. Use case related to Remote Health Care Management
b. Ambulance Management System
c. Medical Asset Tracking
d. Patient Identification

S. No.	Use case title	Brief description
1	Use case related to Remote Health Care Management	Patient can send their health information to a data centre where the doctors can advise based on the Health Parameter received
2	Ambulance Management System	Access to patient record before he/she reach the hospital and the ambulance can also exchange the health information of the patient in case of emergency
3	Medical Asset Tracking	Asset Tracking and Device Tracking is important aspect in the health sector where all the healthcare Instruments need to be tracked in hospital.
4	Patient Identification	The Patient Identification is needed for correct logging of the data in the Electronic Health Record Systems.

Table 3 - Healthcare use cases

6.3 Vertical: Power

a. Automated Meter Reading
b. Advanced Metering Infrastructure
c. Electric Vehicles
d. Home Energy Management / Building Energy Management
e. Substation Automation and Distribution Automation

S. No.	Use case title	Brief description
1	Automated Meter Reading	AMR is used extensively in RAPDRP for HT consumers, distribution transformers and feeders
2	Advanced Metering Infrastructure	Advanced Metering Infrastructure (AMI) is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customer premises equipment
3	Electric Vehicles	eco-friendly and an efficient mode of transport, electric vehicles act as virtual power plants which can provide electricity to the grid, households and buildings during the peak hours
4	Home Energy Management / Building Energy Management	Smart homes would offer monitoring and control of the electricity usage within the consumer Premises. Aggregators or energy management systems would form the core of home automation by providing a means to efficiently consume electricity

5	Substation Automation and Distribution Automation	Modern substations should include 'smart' devices for monitoring and controlling the operation of transformers, circuit breakers, protective relays, capacitor banks, switches, voltage regulators, static VAR compensators, etc.

Table 4 - Utilities use cases

6.4 Vertical: Safety and Surveillance

a. Vehicles with Video Surveillance & Video Tracking Systems
b. Women / Citizen Safety using smart phones / wearable devices
c. City-wide Video Surveillance Systems
d. Video Surveillance for Banks, ATMs, Jewellery Stores, and Similar Establishments
e. Home Safety /Smart Home
f. Citizen Response Management System (CRMS)

S. No.	Use case title	Brief description
1	Vehicles with Video Surveillance & Video Tracking Systems	Video surveillance inside transport vehicles with vehicle tracking system
2	Women / Citizen Safety using smart phones / wearable devices	This use case describes specific handheld devices such as smart phone and/or wearable devicesfor personal safety, primarily for women. These handheld or wearable devices will generate alerts to a central control room during emergencies publishing GPS location data of the person
3	City-wide Video Surveillance Systems	City surveillance Cameras should be able to view traffic situations, accidents, and incidents withclarity along with other objects on road
4	Video Surveillance for Banks, ATMs, Jewellery Stores, and Similar Establishments	Surveillance is to prevent theft and unwanted intrusion, andsabotage during non-office hours and for internal security during office hours
5	Home Safety /Smart Home	Smart Home based on the Wireless technologies for home automation, security and surveillance
6	Citizen Response Management System (CRMS)	Citizen Response Management System will be responsible for receiving emergency alerts, communicating with the user in distress and dispatching the patrolling vehicles, ambulances & fire brigade

Table 5 - Safety and Surveillance Use Cases

7. Identified issues for Future Work

This section gives a brief overview of the tasks and organization of the efforts of the Smart City Group. These are organised as focussed Sub Workgroups and each tasked with their own objectives

On the whole, it intends to lay down the ICT models that should be specified in order to efficiently meet potential future requirements. By providing authorities with ICT supported models of good practice, solutions or processes, efforts can be undertaken and built in a way that will support smart city aspirations at optimal effort and cost.

Primary consideration is given to leveraging and enhancing existing ICT infrastructure that States have already put in place. In addition it is envisioned at a national level and attempts will be made to co-ordinate and collaborate with Government schemes and programs

7.1. Reference framework for Indian Smart cities

Context

A Framework helps capture the various ICT enabled cross-city governance processes that deliver benefits based on core guiding principles, taking due account of critical success factors. Standardisation and interoperability are key requirements for the widespread adoption of technologies and services to provide services at the city level. Cities will need to be able to better integrate wireless networks, data centres and other infrastructural elements, making provision seamless and transparent. Cities will increasingly move from being service providers to platform ones, providing an infrastructure that enables the development of a broad range of public and private applications and services. Standardised technologies and infrastructures is a prerequisite for the development of Smart Cities.

Instead of replicating infrastructure for every city in a state, ideally it makes sense that the different Smart Cities in a State leverage the State level Infrastructure. This will enable:

a. effectiveness of delivery through integration with other services
b. efficiency through dynamic workload migration and sharing of resources
c. more optimal service Quality & Cost Considerations

Objectives

To help converge discussions about the future of Indian cities, ensuring that government, developers, designers, device manufacturers, ICT solution vendors and citizens use a common framework and language.

It is intended to help decision makers develop, agree and deliver common, shareable, ICT strategies that complement their smart city strategies.

7.2. Technical Specification of Smart City Data Model

Context

It will address data models, semantics and data-sharing so that information from different sources can be normalised, classified, shared and understood, both by machines and humans

The derivation of data needs to be linked back to previous layers and the impact of decisions should be observable in operational data. Data could be structured, semi-structured or unstructured, but its common objectives are to offer operational and strategic insight

Objectives:

Suggestion of a data model and an ontology for the city

Develop a common vocabulary and formal knowledge model linked to the City

Creation of open datasets and an open data framework

7.3. General Characteristics of Sensors, Devices and Communication systems for Indian Cities

Context:

Communication systems: are indispensable parts of the public infrastructure in a Smart City. The telecommunications infrastructure is the basis for data generation, exchange of data, control information and their transport that provide intelligence to the city. Within a city, many kinds of communication networks can exist, many kinds of communication networks will be needed to fulfil various needs and all could carry matter relevant for a city's functioning. A smart city must combine legacy networks and new communication architectures in order to configure existing communication networks to achieve compatibility and interoperability

Sensors and Devices: These are needed by a smart city and cover a wide spectrum of Electronics and Computational equipment. Typical devices that are part of a Data / ICT city infrastructure include:

- Sensors, Actuators, HMI's and HCI's
- Chipsets, Modules, Boards, PLC's
- Computers, Servers and Networking LAN infrastructure
- Mobile phones, Tablets and other Handheld devices
- Core Routing Switches & Access Switches
- Wireless Networking Gateways and Routers
- Firewalls and Network Routers
- OSP, Base Stations and Towers

Objectives:

To highlight the communications possibilities for smart cities.

To determine the existence of further opportunities of collaboration in this field, as well as the need to foster further dialogue and discussion on evolving communication networks in cities.

To outline the various networks, the spectrum used for wireless networks, critical communication needs and other related communication infrastructure for cities

To suggest sensors for different domains.

To study the opportunities and challenges imposed by Heterogeneity where sensors/actuators belong to different domains, sensors that use various technologies to communicate, the management of connected objects, their discovery, the naming and addressing of these billions of objects are all items for more detailed study and a separate document

To examine or incorporate from other verticals the model of IP addressing – namely IPv6 as a means for every device to be addressed

7.4. General characteristics of City Planning and Assistance Tools

Context:

Current urban design planning mechanisms in India have long been undertaken through the statutory instrument of the Master Plan (or Development Plan), which has proven time and again to be ineffective in incorporating all the urban complexities of Indian cities. The main reasons for this ineffectiveness include the inability to have sufficient and accurate data collection systems, the time taken to collect the relevant data, disconnect between socio-economic and spatial processes and the static nature of master plans. Additionally, urban efforts have been dispersed across a number of schemes and policies at both the central and state levels.

The opportunity that ICT offers through tools for constant and varied data collection, data analysis, mapping and simulation facilities is that we can create more effective, dynamic and responsive methods of urban planning. ICT can enable us to integrate our various urban initiatives to create more cohesive and inclusive development.

Objectives:

I. **Expanding the scope of Urban Planning with ICT models and tools:** Urban planning is increasingly becoming a trans-disciplinary field and is contributing to the study and measurement of urban systems with an increasing number of physical, social and economic parameters. The digitisation of these researches can be combined, and their interrelations and inter dependability can be studied on a common platform through ICT.

II. **Enabling Dynamic Urban Planning through the use of ICT:** ICTS can enable constant urban data collection and collation. Quantitative data on can be collected through sensors, cameras and other monitoring technology and qualitative, user oriented data collection can be enabled through user feedback and crowd sourcing on digital platforms. The availability of real time data will enable a more dynamic and responsive process of planning and by combining it with urban simulation systems, city planning could respond to the complex interrelations of varied social, economic and spatial parameters.

III. **Create ICT enabled Integrated Planning Systems**: Creating ICT enabled systems where territorial, regional, urban, city and neighbourhood plans are integrated within and respond to each other in terms of frameworks and guidelines. This could be done, for example, by ensuring that the parameters of a Mumbai development plan falls within the framework of the larger plan for the Metropolitan Region, while at the same time acting as a framework for smaller ward plans. This dependency should be achieved through a mechanism where each of these plans provides both an input and response across scales.

IV. **Formulating Methodological ICT driven Frameworks for City Planning:** Using ICT enabled tools to create methodological frameworks for studying and analysing urban systems for planning, and these studies can be used uniformly across cities. This would provide consistency of planning within larger urban development goals, and also ensure minimum standards of development.

V. **Create Capacity Building models and tools:** The increasing accessibility to mobile technology can be harnessed to build capacity of the end users through education, awareness, exposure and access. This accessibility should be enhanced and made available to all citizens as a fundamental public

utility. This would ensure better mechanisms of participation and citizen feedback to support planning mechanisms.

7.5. Technical Specification of Cloud for Smart Cities

Context:

The Smart City Cloud reference architecture will follow the guidelines and framework that CCICI (Cloud Computing Innovation Council of India) is putting in place for e-Governance Reference Architecture. This is based on the FEA (Federal Enterprise Architecture) and the TOGAF (The Open Group Architecture Framework) methodology.

The key architectural considerations for the smart city cloud are:-

I. Hybrid Cloud Architecture.(to enable private cloud service providers to render their domain specific services)
II. Easily integrate with Context Aware devices & sensors through the underlying IOT connectivity fabric
III. Enable Data driven or Data centric architecture
IV. Interoperable with state and national e Governance Clouds
V. Architecturally Secure
VI. Enable data privacy
VII. Support Real-Time-Response
VIII. Based on open standards
IX. Service Quality & Cost Considerations

Objectives:

To begin, the group will study and understand the architectural approach of various Global Forums working on Smart Cities. The knowledge and best practices from these will be used to develop the specifications and architecture for India's Smart City Cloud Infrastructure

The efforts of this group will be to attempt to address the following questions:

- Why is it important to consider Cloud for the ICT Infrastructure?
- How will this interplay with State, National and Public service providers ICT Infrastructure?
- What are some proposed guidelines for the approach to be adopted? For instance It makes sense that Smart City Infrastructure should leverage the State level Infrastructure for:
    I. effectiveness of delivery through integration with other services as well as
    II. efficiency through dynamic workload migration and sharing of resources

- The emphasis needs to be on the Integration of Applications - to enable "single window service delivery". This would require data from different sources, for example: Different clouds / Data Centres. Hence a data driven architectural approach is important. The underlying infrastructure may be a federation of Clouds and hybridised Data Centres providing the interfaces for easy integration of application and optimal sharing of resources.

8. Way Forward

1. At a top level, the efforts of this Work Group are to lay down the ICT framework & models that are necessary to efficiently meet potential requirements by Smart Cities. As such it is expected to provide authorities and industry with ICT supported framework & models of good practices, solutions or processes, such that initiatives can be undertaken and built in a way that will support smart city aspirations at optimal effort and cost.
2. In particular, strive to undertake the tasks and activities as laid out in Section 7, Identified issues for future work.
3. In considering the work needed to develop Smart City standards, it is important to undertake a gap analysis of existing Smart City related standards by various national & international organisations.
4. It will be important to collect requirements relevant to the Indian ecosystem and draw up a Technical Report to assess ICT part of smart city standards both horizontal & vertical aspects while covering smart citizen, and accessibility related standards including data protection/privacy, with reference to existing and planned standardization activities.
5. There is a need to complement and collaborate both internally and externally including Standards Organisation; internally with the other Working Group members at TEC and externally with other local & global agencies or bodies involved in similar activities. As such a task force dedicated to liasoning activities could be considered.
6. The most crucial imperative in the standardisation initiatives in the Smart city paradigm shall be to harmonize the Standards amongst the multiple stakeholders of Smart City Ecosystem: namely the Standards in Smart Homes, Smart Buildings, Smart Grids, Smart Mobility etc. shall need to be made interoperable at various levels to make the City ICT Infrastructure work in Homogeneous fashion in spite of addressing a whole spectrum of heterogeneous applications.
7. It shall be imperative to understand and enumerate the Key Performance Indicators of the ICT Infrastructure in a Smart City…
8. Efforts will be made to create visibility and awareness among the industry and government about the strategy and the deliverables of the Work Group to enhance participation.
9. Efforts will be made to align with the governments "100 Smart Cities", "Make in India", "Digital India", "and Swachh Bharat Mission" and other initiatives brought in from time to time.
10. Invite more stakeholders to join the initiative and work towards a single national objective. This will ensure wider acceptability of the technologies as well as economies of scale.

9. References

This report refers to the following standards, specifications, articles and papers:

1. CEN-CENELEC-ETSI Coordination Group 'Smart and Sustainable Cities and Communities' (SSCC-CG)
2. PAS 180:2014, Smart cities – Vocabulary, BSI.
3. SSC-0100-rev-2, Smart Sustainable Cities – Analysis of Definitions, ITU-T FG SSC.
4. PAS 181:2014, Smart city framework – Guide to establishing strategies for smart cities and communities, BSI.
5. ISO-IEC JTC 1 N11712 CESI contribution on possible work on Smart Cities, ISO/IEC JTC 1
6. TEC M2M Technical Reports in (Power Secor, Remote Health Management, Intelligent Transport System, Safety and Surveillance Systems)(http://www.tec.gov.in/technical-reports/)
7. TSDSI report on Smart Cities - An overview of the role of Information and Communication Technologies in the Indian context.
8. National Telecom M2M Roadmap, released by DoT(www.dot.gov.in/ntcell)
9. National Telecom Policy 2012, released by DoT (www.dot.gov.in/ntcell)
10. ISO 37120 - Sustainable development of communities — Indicators for city services and quality of life
11. ISO/TR37150 - Smart community infrastructures —Review of existing activities relevant to metrics
12. ISO/TS 37151 - specifications for smart community infrastructure performance.
13. http://smartcities.gov.in/writereaddata/SmartCityGuidelines.pdf

Annexure I – Services and Applications for different Smart City pillars

The draft Concept note on Smart Cities by the MoUD identified 4 pillars of Smart Cities. These are Physical Infrastructure, Social Infrastructure and Institutional Infrastructure. This was then extended to include Economic Infrastructure. Basing applications and services on this classification we can look at applications and services that enrich these spaces.

Services and Applications for Physical Infrastructure

Physical infrastructures and the services and applications that run on top of, or cater to the physical infrastructure comprises of:

No.	Physical Infrastructures	Smart Services and Applications
1.	Energy	Smart Electricity Management Smart Power Grid Smart Metering for Electricity and Gas Smart Gas pipeline Management Smart Lighting
2.	Buildings	Smart buildings CCTV Surveillance
3.	Transportation	Smart Transportation (across roads, bridges, highways, local trains, buses, cabs, metro train, ports, airports) Route Optimization Smart Ticketing Smart Signage Smart Parking Interactive Bus Stops
4.	Water	Smart Water Management Smart Metering Water Leakage Detection Smart pipes and sensor networks Smart Irrigation management
5.	Waste Management	Smart Waste Management Waste tracking systems
6.	Housing	Integrated Building management Housing finder Housing plan management and tracker
7.	Disaster Management and Emergency	Integrated Response and Management for Regional Police Headquarters, Coastguard facilities (for coastal cities), Fire Headquarters, Hospitals, Ambulance and Administrative Departments
8.	Public works	Smart Management of Public Works – Dams, Canals, Subways Smart Public Lighting

Table 6 - Smart applications for Public Infrastructure

Services and Applications for Social Infrastructure

Services and applications that run on top of, or cater to Social infrastructure include:

No.	Social Infrastructures	Smart Services and Applications
1.	Safety and Security	Smart physical safety and security City Surveillance Remote Monitoring
2.	Health Care	Smart health care
3.	Education	Remote Education
4.	Entertainment	Open public access digitally
5.	Environment	Smart Lighting Smart Irrigation management
6.	Homes and Buildings	Controlling appliances remotely Home security, climate control and lighting.

Table 7 – Smart applications for Social Infrastructure

Services and Applications for Institutional Infrastructure

Services and applications that run on top of, or cater to Institutional infrastructure include:

No.	Institutional Infrastructures	Smart Services and Applications
1.	Service Delivery	Smart Digital Transactions
2.	Transparency and Accountability	Models, optimization, and decision-support tools
3.	Citizens Participation and Advisory	Citizens interface to policy Direct voting
4.	Justice and Judicial System	Transparent, Integrated Legal processes Smarter Court System

Table 8 – Smart applications for Institutional Infrastructure

Services and Applications for Economic Infrastructure

Services and applications that run on top of, or cater to Economic infrastructure include:

No.	Economic Infrastructures	Smart Services and Applications
1.	Job Creation	Remote Education Smart Evaluation
2.	Livelihood Activities	Environmental Information Access to Experts
3.	Transparency and Accountability	Remote Education
4.	Taxation	Tax calculator and filer Claims management

Table 9 – Smart applications for Economic Infrastructure

Annexure II - Global Cloud Landscape

An example of standardising the cloud infrastructure is along the NIST's Cyber Physical System recommendation[5]as this emerging technology is being adopted world-over for smart city ICT implementation.

Annexure III – Smart City middleware

Large number of services will be needed to facilitate Smart Living, Smart Economy, Smart Environment and Smart Governance. Each component – for example, Smart Living – in itself will require multiple applications to be prioritised to align with the governance strategy for each city.

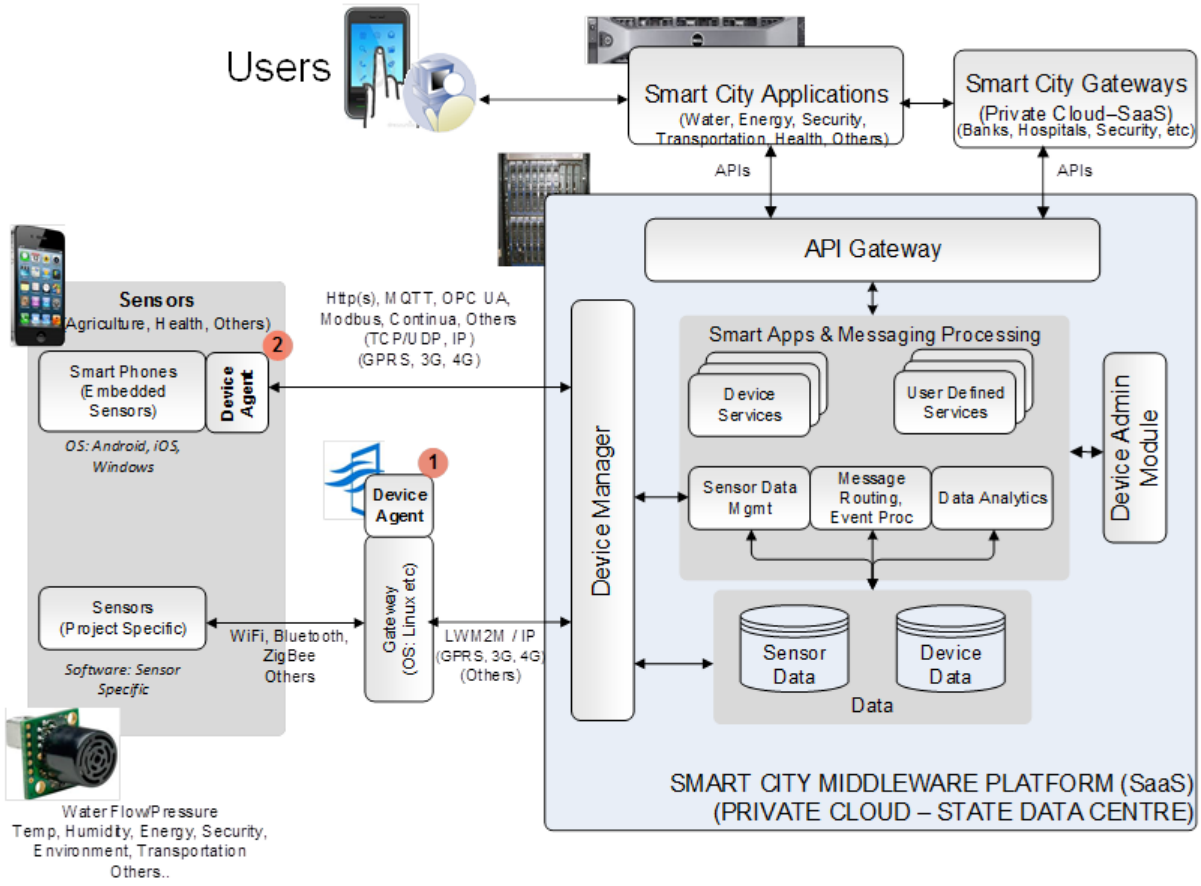
Whatever be the Smart Services Component, the sophistication and intelligence of the services will depend on the number of parameters that could be monitored and analysed by backend decision-making systems for automatically initiating corrective actions and notifications to concerned stakeholders. For example, number and accuracy of sensors installed in District Metering Areas will define the sophistication of Water Management Systems and the requisite proactive actions.

While the number and types of such devices will be determined by each Service of a Smart City, it is fair to assume that total number of such devices will be very high. In addition, such devices are likely to use widely varying types of communication protocols. Therefore, it is suggested that the overall architecture should consider some Smart City Middleware platform that could be procured Software-as-Service (SaaS) to interconnect sensors / devices on one side and Smart City Applications on the other end of the architecture.

The Smart City Middleware could be installed on existing IT Infrastructure available in State Data Centres (SDC) to form Private Cloud for the state. As the number of devices and workload increases, it is possible to explore Public Cloud model that meets security related specifications for the state.

Multiple types of solutions are possible for Smart City Middleware with the critical factors being the flexibility to support all types of devices, network communication protocols and sophistication of Devices Message Processing Engine. It should be emphasised that the following diagram is just a depiction at SaaS level while underneath IT Infrastructure, or Infrastructure-as-a-Service (IaaS), is more likely to be existing Data Centres forming Private Cloud:

[5]http://nist.gov/cps/sagc.cfm



Source: CCICI **Figure 3: Cloud Architecture for Smart City Middleware, Gateways and Applications (Suggestive)**

Figure 3 above shown above suggests use of Smart City Middleware platforms that could be procured as Service and installed in the existing IT Infrastructure. The emphasis on devices is due to the key role played by these devices for remote monitoring of the parameters impacting the quality of Smart Services being delivered to the people.

Besides middleware, other gateways services are also likely to be valuable to the overall Smart Architecture. For example, it is possible to identify Hospital Information Exchange Services for integrating various hospitals in one city as well as across cities. Similarly, financial gateways will automate online digital businesses.

TELECOMMUNICATION ENGINEERING CENTRE
DEPARTMENT OF TELECOMMUNICATIONS
MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY
GOVERNMENT OF INDIA