FRAMEWORK ON SMART CITIES STANDARDISATION IN RELATIONS TO INFORMATION & COMMUNICATIONS ASPECTS

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Contents

Page

Figures

Tables

Annex

Committee representation

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Al Hijrah Media Corporation
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AZTECH
Celcom Axiata Berhad
Cisco Systems Malaysia
Consumer Forum Malaysia
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Cybersecurity Malaysia
Cyberview Sdn Bhd
Dagang Teknik Sdn Bhd
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Pernec Corporation Bhd
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RedTone IoT Sdn Bhd
Samsung Electronics Display (M) Sdn Bhd
Samsung Malaysia Electronics (SME) Sdn Bhd
SIRIM Berhad
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Telekom Applied Business Sdn Bhd
Telekom Malaysia Berhad
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TIME dotCom Berhad
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Altel Communications Sdn Bhd
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Cybersecurity Malaysia
Cyberview Sdn Bhd
DiGi Telecommunications Sdn Bhd
Geo Dimension
Intel Corporation
Huawei
Knowledge Group of Companies
Maxis Communications Berhad
Measat Broadcast Network Systems Sdn Bhd
Malaysia Digital Economy Corporation (MDEC) Sdn Bhd
Multimedia University
My6 Initiative Berhad
Pernec Corporation Bhd
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Foreword

The concept of smart cities has risen from the emerging urbanisation phenomenon occurring across the planet. The United Nation (UN) estimated that approximately 60 per cent of our global population will live in cities by 2030[1]. The urbanisation trend is also prevalent in our country where currently 75 per cent of Malaysians resides in urban areas[2]. Furthermore, we are in the stage of shifting from an emerging market to a developed market and 'smart solutions' are seen as the key towards growth. This developed market-goal is expected to be achieved by 2020 and it is an essential component towards the implementation of smart cities and communities in Malaysia.

The key enabler for smart cities development is information and communication technologies (ICT). Integration of these technologies into cities major processes can make it smarter and more efficient in managing urban challenges. Even the Eleventh Malaysia Plan (RMK-11) emphasises on driving ICT in the knowledge economy through innovation and productivity to enhance competitiveness and wealth creation. However, we have to ensure that the numerous technologies deployed in cities are interoperable, safe and regulated.

In this regards, there is an urgency for the development of information and communications frame of reference for smart cities which can act as the foundation and guidance for the standardisation activities within the ICT industry as well as the other industries.

The 'Framework on Smart Cities Standardisation in Relations to Information and Communications Aspects' was developed by the Focus Group on Smart City of the Internet of Things Working Group (IoT WG) under the Malaysian Technical Standards Forum Bhd (MTSFB). The Focus Group is an industry-driven forum established to facilitate the standardisation efforts of smart cities and communities in Malaysia.

The document has gone through an extensive assessment during the development process that includes review at multiple draft stages by the committee and relevant stakeholders, as well as public commenting procedure. Subsequently, this document has been approved by the Malaysian Communications and Multimedia Commission (MCMC).

The main objective of this document is to provide a working standardisation reference for stakeholders to consider. Through this framework, the complexities of smart cities implementation are fragmented into several basic components, which can be addressed independently by respective stakeholders. The collective effort of stakeholders in enabling standardisation and regulatory initiatives will be a solution in addressing challenges and issues pertaining to the development of smart cities in Malaysia.

[1] The World's Cities in 2016 - UN

[2] The World Bank 2015

Abbreviations and definitions

Abbreviations

For the purposes of this framework, the following abbreviation applies.

EMF	Electromagnetic Field
FG-SSC	Focus Group on Smart Sustainable Cities
GIS	Geographic Information System
ICT	Information and Communications Technology
IoT	Internet of Things
ISO	International Organization for Standardization
ITU	International Telecommunications Union
OAM & P	Operation, Administration, Maintenance and Provisioning
PON	Passive Optical Network
RFID	Radio Frequency Identification
SAC	Standardization Administration of China
WPAN	Wireless Personal Area Networks

Definitions

For the purposes of this framework, the following definitions apply.

Smart city (SC)	A smart city is an innovative city that promotes the convergence of information and communications technology 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, environmental as well as cultural aspects.
Convergence	Convergence of information technology (hardware and software used to store, retrieve, and process data) and communication technology (electronic systems used for communications between individual or groups) through digitalisation that allows for different types of content (data, audio, voice, video) to be delivered through a variety of medium or to be executed in different platforms (computers, mobile phones, television). Previously separate technologies such as voice (and telephony features), data (and productivity applications), and video can now share resources and interact with each other synergistically.
Device	With regards to the IoT, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and processing.
Thing	With regards to the IoT, this is an object in the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communications network.

FRAMEWORK ON SMART CITIES STANDARDISATION IN RELATIONS TO INFORMATION AND COMMUNICATIONS ASPECTS

1. Scope

This framework has been prepared to provide standardisation activities with regards to the development of standards for smart cities, with a specific focus on the information and communications layer. This standardisation framework aims to assist various stakeholders from government and non-government bodies, agencies and organisations, as well as industry and academia in working together for development of smart cities in Malaysia.

2. Background

2.1 Requirements

Digital technology advancement has a strong association with economic development, social inclusion and environmental protection[3]. Converged technology have the potential to drive disruptive and transformative changes across every sector of society. Due to this, Malaysia has always been a proponent of utilising ICT to achieve smart sustainable development.

The International Telecommunication Union (ITU) has established the ICT Development Index (IDI), which measures the level of ICT development in 175 economies worldwide and compare progress since 2014. Table 1 shows the comparison of the IDI Value for Malaysia between developed and developing countries. In 2016, Malaysia has a higher IDI value than the Developing Countries, and climbing towards the IDI value of Developed Countries. Malaysia is ranked 62 out of the 175 countries measured in this index. Table 2 shows the IDI ranking for the Asia Pacific region. Within this region, Malaysia is ranked on the top 10 countries in Asia, and the second in the ASEAN region next to Singapore.

Table 1. ICT Development Index (IDI) showing Malaysia's position shifting towards high IDI value of developed countries.[4]

IDI value	Developed countries	Malaysia	Developing countries
2016	7.40	6.22	4.07
2015	7.25	5.64	3.85

[3] Information & Communication Technology Key to Enable Sustainable Urbanization 2016 - UN-Habitat

[4] Measuring the Information Society Report 2016 - ITU

Table 2. Asia Pacific countries and their respective world ranking for IDI 2016.

Country	IDI 2016 rank	IDI 2016 value	IDI 2015 rank	IDI 2015 value	Rank change
Korea (Rep.)	1	8.84	1	8.78	-
Hong Kong, China	6	8.46	7	8.40	⇧
Japan	10	8.37	11	8.28	⇧
Singapore	20	7.95	19	7.88	⇩
Malaysia	61	6.22	66	5.64	⇧
Brunei Darussalam	77	5.33	74	5.25	⇩
Thailand	82	5.18	79	5.05	⇩
Viet Nam	105	4.29	104	4.02	⇩
Philippines	107	4.28	106	3.97	⇩
Indonesia	115	3.86	115	3.63	-
Cambodia	125	3.12	127	2.78	⇧
Myanmar	140	2.54	153	1.95	⇧
Lao P.D.R.	144	2.45	144	2.21	-

The previously given definition provides this document with the following characteristics for a smart city.

It concerns an urban space with innovative - not necessarily based on ICT-features. However, the context of smart cities in this document focuses on architecture of which information and communications have a crucial role amongst the other innovative solutions and city facilities.

These innovation solutions address the following urban dimensions:

a) society - to deliver today and future generations' requirements, by enhancing wellbeing, spiritual and social coherency, as well as efficiency regarding energy, food, water, etc.;

b) environment - to include protection, waste and emissions control against climate change;

c) governance - to ensure urban utility and service availability; and

d) economy - in terms of sustainable growth, smart solutions to increase efficiency and productivity, and city competitiveness (attracting habitants, visitors and businesses).

2.2 Information and communications convergence as an enabler for smart cities

Information and communication technologies are necessities for smart cities due to their capacity to gather, process, analyse and disseminate considerable amount of data that can increase the efficiency of city functions in terms of resource consumption, services, and lifestyles. The convergence of technologies (such as mobile broadband, Internet of Things (IoT), advanced robotics, artificial intelligence and big data analytics) from telecommunications, broadcasting and multimedia sectors is the key enabler towards successful smart city development.

IoT is one of the catalyst since it has the potential of merging the physical world and the virtual world through providing the internetworking between devices (such as sensors and actuators) that interfaces with physical objects (such as vehicles, buildings and other “things”) with the powerful and disruptive computing world (such as the mobile, social, big data, cloud computing, machine intelligence and others) by virtue of their connectivity via the Internet. This leads to new scenarios that would not be possible before such as intelligent buildings, real time predictive analytics and control, smart manufacturing, autonomous vehicles, personal assistants and robots, high quality speech recognition and others.

Figure 1 explains how information and communications technologies serves as a fundamental base in supporting the smart city vision to increase quality of life by addressing four (4) dimensions of city as described previously. This ecosystem is scalable from a micro-level Intelligent Lifestyle, in which devices are connected at a personal level. When

several personal level connected devices interact among each other and the surrounding devices, this ecosystem is termed Smart Cities and Communities. As cities-wide network and devices interact among other cities at a country-wide scale, this ecosystem is termed Digital Nation.

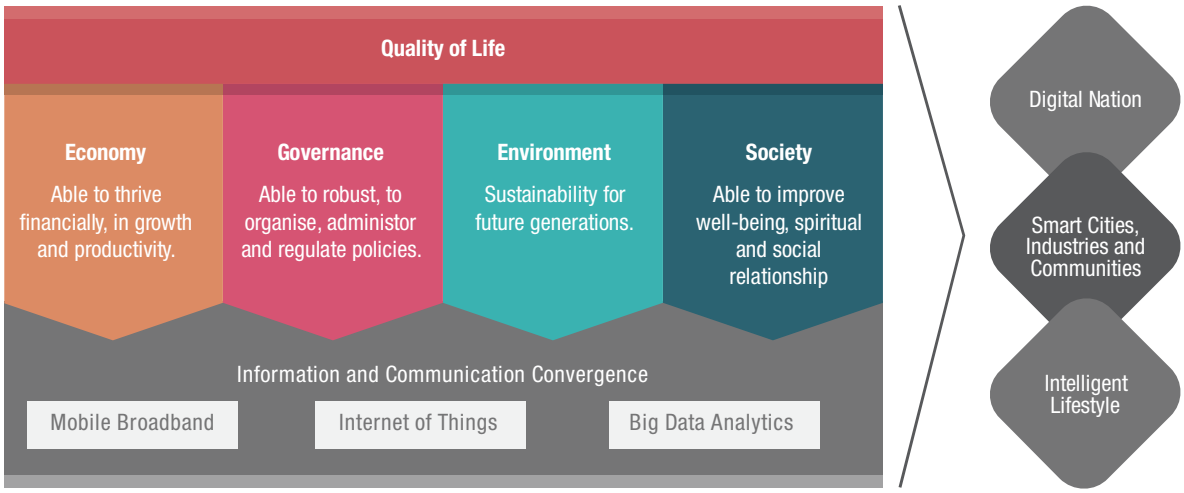

Figure 1. Information and communications convergence as an enabler in supporting smart city vision

2.3 Infrastructure classifications for smart cities

Smart city infrastructure can be classified according to the type and corresponding development stage to the following categories:

a) hard infrastructure - this category refers to physical infrastructure either ICT or non-ICT based to address issues such as mobility/transport, basic amenities and utilities such as water, waste, and energy, as well as Internet and broadband connectivity and coverage; or

b) soft infrastructure - this category refers to non-physical aspects of requirements such as human capital, knowledge and IT literacy, social adaptation and inclusion, privacy and trust, as well as effective policies and planning.

2.4 Smart cities stakeholders

As defined in ITU-T publications on smart cities ITU TR SSC-0113, a stakeholder is defined as any entity, an institution or an individual, that has an interest in smart cities or that can significantly influence or be influenced by its deployment. As such, the following set of stakeholders has been identified:

a) municipalities, city council and city administration - this category refers to organisations that are responsible for city management and maintenance, and therefore are considered the local champion for smart initiatives;

b) national and regional governments - this category refers to national-level planners and policy makers that have direct or indirect impact on smart cities implementation;

c) city services companies - this category refers to city services organisations and operators which will be implementing smart city solutions and maintenance;

d) utility providers - this category refers to utility providers which are directly related and impacted by implementations of smart city solutions such as smart grid or smart water management;

e) ICT companies (telecom operators, start-ups, software companies) - this category refers to solution providers or system integrators for ICT infrastructures, platform and integrated solutions;

f) Non-Government Organisations (NGOs) - this category refers to non-profit non-governmental organisations that support the smart city vision, which plays an important role in influencing society and mobilising community especially on the axis of social sustainability;

g) international, regional and multilateral organisations - this category refers to international agencies and multilateral organisations. These agencies can be promoters of initiatives towards human development, environmental sustainability and improvement of quality of life worldwide, as well as financing smart cities initiatives;

h) industry associations - since industries are interested in the deployment of smart city, industry associations also work towards the success of this new model;

i) academia, research organisations and specialised bodies - research and academic institutions involve in understanding smart city development, technology and associated trends, including its impacts and contributions to sustainable development;

j) citizens and citizen organisations - as users of cities, citizens are affected both directly and indirectly by smart city deployment;

k) urban planners - their expertise is important to better understand how to include ICTs into medium and long term city planning, as well as to consider urban complexities; and

l) standardisation bodies - these are critical to ensure a common terminology and minimum characteristics of a smart city, as well as to define measurement methods to assess the performance and sustainability of city services based on ICT technologies.

2.5 Characteristics concerns of smart cities

The previously identified context regarding needs, scope and stakeholders illustrate that there's a broad environment where the smart city information and communications architecture has to be applied, which addresses:

a) different geographic areas - various political, economic, technological, social and cultural characteristics**;**

b) different technological artefacts - which potentially have been applied in the urban space (i.e., existing information and communication solutions that have been developed by alternative stakeholders; public or private broadband networks, etc.);

c) size and type of the city - such as small versus global cities and capitals; new versus existing cities accordingly, which differentiate the size of smart city information and communications impact and availability requirements, as well as the capability to install various hard infrastructure (simple for new cities and blocks, compared to historical cities); and

d) different timeframes - within which the smart city information and communication architecture is requested to operate, for which small communities change more slowly and their needs accordingly, compared to global cities.

2.6 Architecture principle of smart cities

The architectural principles that enable the smart city information and communications architecture to align to the above characteristics concern:

a) layered structure - layered architecture has been proved to be applied in the mostly well managed smart city cases and can be applicable to most cases. Some layers have already introduced by the ITU FG-SSC 0097 specifications document on smart sustainable cities infrastructure such as, the data and communication layer. However, exceptions have to be considered in cases where the smart city is not centrally and simultaneously developed, such as many in European cases;

b) interoperability - interoperability needs to be ensured among heterogeneous and distributed systems in smart cities for provision and consumption of a variety of information and services;

c) scalability - the smart city information and communication architecture has to be able to scale-up and down according to the size of city, the demand for services or business changes within the smart city;

d) flexibility - cutting-edge (i.e., cloud computing, IoT, etc.) and emerging technologies have been able to be adopted, while physical or virtual resources have to be rapidly and elastically adjusted to provide various types of smart city services;

e) fault tolerant - many quality attributes concern themselves with the availability of the architecture and its hosted componentry. Although fault tolerance is a rather strong phrase, it states the apex to which services and the architecture should aspire;

f) availability, manageability and resilience - service availability must be ensured according to the smart city user demand, disaster recovery must be provided in various levels, manageability relates to operational concerns in a sense that managing the architecture directly supports smart city information and communication operations. Manageability at a systems/subsystems level has to be secured in order to allow normal operations of equipment, networks and applications, especially considering more and more operation process would be managed automatically;

g) standards-based - this principle has an identifiable tension with that of technology and vendor independence. Essentially, an organisation endorses this principle to ensure contestability, replace ability, and longevity; and

h) technology and/or vendor independence - Smart cities and mainly those that run under the state supervision and/or funding, require that architectures, solutions, or services be vendor-independent, to facilitate contestability, replacement, or simpler interoperability or integration. Vendor independence may also compromise one's ability to negotiate preferential rates or treatment, and it is not unusual for (larger) organisations to nominate a preferred list of suppliers for certain services, allowing a degree of negotiation to occur to support cost containment.

3. Framework for smart cities standardisation

A framework for smart city standardisation initiative is imperative to provide clear demarcation of scope of roles and responsibility for participating standard development organisations (see Figure 2).

A document on smart city standardisation framework has been published by the ITU FG-SSC 0097 specifications document on smart cities infrastructure. This document has been referenced and adopted by several other major standard development organisations to include IEEE and ISO/IEC.

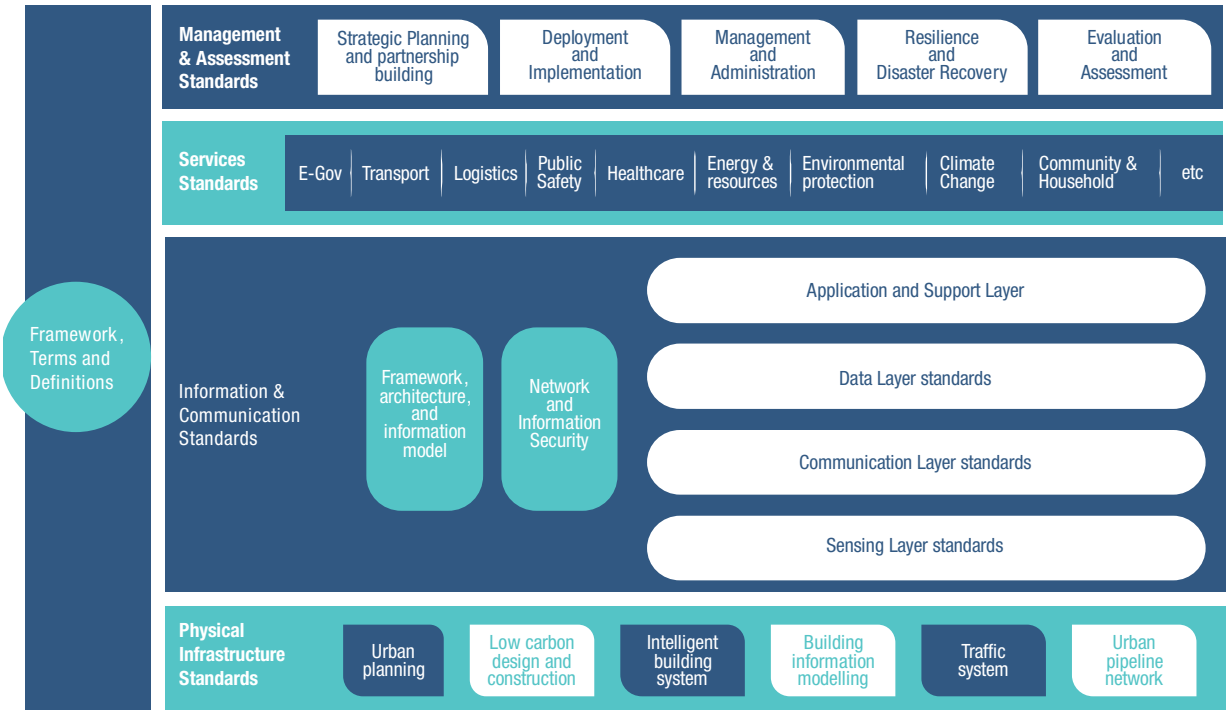

Figure 2. Smart City standardisation framework that is widely adopted by international standard development organisations[5]

[5] ITU-T Technical Reports and Specifications on Smart Sustainable Cities - Shaping smarter and more sustainable cities Part 5.1

Standards for smart cities can be generally classified into four (4) categories as follows:

a) management and assessment;

b) smart city services;

c) information and communications; and

d) buildings and physical infrastructure.

3.1 Management and assessment

3.1.1 Strategic planning, business model and partnership building

Work conducted within this area should cover the scope of business model, strategic planning and partnership building of smart cities.

The tasks include, but are not limited to:

a) developing a viable business model for smart cities initiatives;

b) developing guidelines and best practices for the requirements analysis in smart cities;

c) developing guidelines and best practices for the strategic planning mechanisms and methods in smart cities; and

d) developing guidelines and best practices for the partnership building mechanisms and methods in smart cities.

3.1.2 Deployment and implementation

Work conducted within this area should cover the scope of deployment and implementation of smart cities.

The tasks include, but are not limited to:

a) developing guidelines and best practices for the deployment procedures in smart cities; and

b) developing guidelines and best practices for the implementation procedures in smart cities.

3.1.3 Management and administration

Work conducted within this area should cover the scope of management and assessment of smart cities.

The tasks include, but are not limited to:

a) developing a code of conduct for the management in smart cities; and

b) developing a code of conduct for the administration in smart cities.

3.1.4 Resilience and disaster recovery

The standardisation of the following areas should be implemented in the management and assessment of smart cities.

The tasks include, but are not limited to:

a) developing guidelines and best practices for the resilience in smart cities; and

b) developing guidelines and best practices for the disaster recovery in smart cities.

3.1.5 Evaluation and assessment

The standardisation of the following areas should be implemented in the management and assessment of smart cities.

There are several technical report and technical specifications on key performance indicators of information and communications technologies for smart sustainable cities developed by FG-SSC (ITU-T L. KPIs-overview, ITU-T L.KPIs-ICT, ITU-T L.KPIs-impact, ITU-T L.KPIs-supp).

The task includes, but is not limited to developing recommendations for the methodology of evaluation and assessment for smart cities.

3.2 Smart city services

3.2.1 E-government

The standardisation of e-government should support the services related to government affairs that are provided to city residents. The technologies of e-government include, but are not limited to information sharing, electronic document sharing, and data directory service.

The tasks include, but are not limited to:

a) developing guidelines for the services of e-government related to smart cities that include online city information availability, online civic engagement, online support for new city residents, strategies to enable ICT literacy of residents, etc; and

b) developing a series of technical standards including the terms and definitions, service models, information management, and safety and security, etc., in the e-government of smart cities.

There are some fundamental standards on information technologies in ISO/IEC, including:

a) vocabulary;

b) metadata registries;

c) software product evaluation;

d) security techniques (evaluation criteria for information technology (IT) security, digital signatures with appendix, entity authentication, non-repudiation); and

e) open systems interconnection (security frameworks for open systems, systems management).

There are some fundamental standards on data exchange service, including:

a) office automation;

b) real-time information releasing;

c) transparency around governmental decision-making and open data; and

d) electronic public-opinion polling.

3.2.2 Transport

The standardisation of transport issues in smart cities should fulfil the requirements of passengers, drivers, vehicles, traffic infrastructures, etc.

The services of city transport system include but are not limited to traffic information services, traffic telematics, information exchange between vehicle to vehicle (V2V), vehicle to infrastructure (V2I), and vehicle to everything (V2X), and traffic emergency processing.

The tasks include, but are not limited to:

a) developing guidelines for integrated services within smart cities intelligent transport systems;

b) developing recommendations for guidelines and best practices related to the services and functional requirements of the traffic emergency processing for smart cities;

c) developing recommendations for guidelines and best practices related to the implementation of smart cities mobility and transport services with a view to addressing environmental challenges; and

d) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

(ITU-T TR infrastructure) discusses ICT infrastructure in smart cities which involves facilities of IoT. There are several technical committees (TCs) working on traffic/transport standardisation in ISO/IEC.

3.2.3 Logistics

The standardisation of logistics in smart cities should fulfil the service requirements related to consignor, consignee, carriers, goods, and warehouses.

The tasks include, but are not limited to:

a) developing guidelines for integrated services regarding logistics in smart cities, including supply chain services, business intelligence, and electronic payments etc.

b) developing recommendations for guidelines and best practices related to the implementation of logistics services with a view to addressing environmental challenges.

c) providing the necessary collaboration for joint activities in this field between SDOs conducting related work on smart cities, consortia and forums.

The “GS1 Standard 1” focuses on the management of objects in the supply chain and is widely accepted as an international standard.

3.2.4 Public safety

The standardisation of public safety in smart cities should fulfil the service requirements of citizens.

The services of public safety for smart cities include, but are not limited to crime reduction, tackling natural and man-made disasters, and emergency response.

The tasks include, but are not limited to:

a) developing guidelines for services relating to public safety and security in smart cities, including crime reduction, anti-terrorism, disasters management, emergency response, etc.;

b) developing guidelines relating to measures and facilities of public safety and security in smart cities, such as flood control, fire control, food and drug quality tracing, etc.; and

c) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

3.2.5 Health care

The standardisation of health care in smart cities should fulfil the service requirements of city residents, patients, hospitals, and health centres.

The services of health care include but are not limited to e-health monitoring services, health informatics, medical informatics, and telemedicine.

The tasks include, but are not limited to:

a) developing guidelines for services related to health care in smart cities based on the existing health care related standards, including electronic health records, electronic medical records, medical resources and information sharing, telemedicine, etc.;

b) developing guidelines for the system and interfaces with existing health care related standards;

c) developing guidelines for the strategy of improving resident health such as: mitigation of exposure to the electromagnetic field (EMF), noise, pollution, etc.; and

d) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

WHO, CEN/TC 251, ISO/TC 215, ITU-T SG13, and ITU-T FG M2M are working on all aspects of health care standards covering areas from doctors and nurses to patients, from hospitals to home and electromagnetic field. These standards are widely used in the health care industry.

3.2.6 Governance of urban infrastructure

The standardisation of the governance of urban infrastructure in smart cities should fulfil the service requirements of city infrastructures.

The city infrastructure includes but is not limited to road transport, street lighting, urban landscape, and urban underground pipelines.

The tasks include, but are not limited to:

a) developing guidelines for services related to urban governance in smart cities based on the existing urban governance standards;

b) developing guidelines for the system and interfaces based on the existing urban governance application in smart cities;

c) developing recommendations for integrated management in smart cities (high level requirements, framework, meta-model, data fusion, management services, cooperation in creation of infrastructure and sharing among service providers etc.); and

d) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

There are some technical reports on integrated management and corresponding best practices in FG- SSC which concentrate on decision making, urban operations and services (ITU-T TR management, ITU-T TR water).

ISO TC 268 is working on the management of smart community infrastructures. Also, some national organisations, such as The American Society of Civil Engineers (ASCE) and their counterpart in China (Standardisation Administration of China (SAC)), have this kind of standards and technical documents.

3.2.7 Energy and resources management

The standardisation of energy and resources management should fulfil the service requirements of industries, residential dwellings and public facilities related to energy and resources management in smart cities.

The energy and resources management includes, but is not limited to power supply, water supply and sanitation, oil supply, gas supply, and city minerals.

The tasks include, but are not limited to:

a) developing guidelines for energy consumption in smart cities (data collection, statistics, analysis, etc.);

b) developing guidelines for resources supervision in smart cities;

c) developing guidelines for energy efficiency in smart cities;

d) developing recommendations for methodology of energy evaluation in the household; and

e) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

ISO, IEC and ITU-T are working on the smart grid and smart metering in energy and resources management as well as on energy efficiency. However, since the scope and boundary of the standards is not limited to the region of a city, more efforts related to integrated energy and resources management, including power, gas, water and sanitation in cities, are required.

3.2.8 Environmental protection

The standardisation of environmental protection should fulfil the service requirements of industries and residential dwellings related to environmental protection in smart cities.

The services of environmental protection include but are not limited to EMF, solid waste management, e-waste management, pollution source monitoring, toxic substance monitoring, and noise monitoring.

The tasks include, but are not limited to:

a) developing recommendations for integrated environmental assessment in smart cities (EMF, solid waste management, e-waste management, pollution source monitoring, toxic substance monitoring, noise monitoring);

b) developing guidelines for exposure to environment pollution (EMF, chemicals, radiation, noise, etc.); and

c) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on smart cities.

3.2.9 Climate change adaptation

Standardisation related to climate change should fulfil the service requirements of industries related to climate change in smart cities.

The services of information and communication and climate change for smart cities include, but are not limited to tackling climate change in cities.

The tasks include, but are not limited to:

a) developing guidelines for climate change assessment (adaption and mitigation) in smart cities;

b) developing guidelines for ICT use in Green House Gas (GHG) emissions; and

c) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting related work on SC.

3.2.10 Community and household

Standardisation related to districts should fulfil the service requirements of residents, and communities in smart cities.

The tasks include, but are not limited to:

a) developing recommendations for smart districts, including scenarios, use cases, best practices, and security etc.; and

b) developing recommendations for smart communities with linkage to e-government, public safety, emergency response, healthcare, energy and resources management, etc.

3.3 Information and communications

3.3.1 Information and communication framework, architecture and information model

The standardisation of smart cities framework, architecture and information model should be based on and as an expansion of the related information and communication standards, supporting the development of smart cities.

The tasks include, but are not limited to:

a) developing recommendations for:

   i) terms and definitions related to smart cities from an information and communication perspective;

   ii) characteristics, high-level requirements and general capabilities of smart cities;

   iii) information model of smart cities from a spatio-temporal perspective; and

   iv) information and communication infrastructure/services available in smart cities/architecture framework and technical requirements of smart cities.

b) developing recommendations on guidelines, methodologies and best practices to help cities to deliver information and communication services including (but not limited to) integrated management, IoT, big data and open data with a view to addressing social, economic, and environmental challenges; and

c) providing the necessary collaboration for joint activities in this field between SDOs, consortia and forums conducting relevant work on smart cities.

There are several technical reports on smart cities terms and definitions, characteristics and attributes, and infrastructure which concentrate on ICT infrastructure in FG-SSC (ITU-T TR SSC Def, ITU-T TR overview, ITU-T TR infrastructure).

3.3.2 Network and information security, availability and resilience

The standardisation of network and information security should be based on and expand the related information and communication standards, supporting the security requirements of smart cities.

The task includes but is not limited to developing the guidelines for network and information security in smart cities.

3.3.3 Application and support layer

The standardisation of the following technologies should be implemented in the application and support layer of smart cities:

a) Service Oriented Architecture (SOA);

b) information presence;

c) integrated management; and

d) decision-making.

The tasks include, but are not limited to:

a) developing guidelines for the interface of application and support layer standards in smart cities; and

b) developing guidelines for three dimensional (3D) virtual reality of smart cities, city simulation, web services for smart cities, etc.

3.3.4 Data layer

The standardisation of the following technologies should be implemented in the data layer of smart cities:

a) cloud computing;

b) data exchange; and

c) Geographic Information System (GIS).

The tasks include, but are not limited to:

a) developing guidelines for the interface of data layer standards in smart cities; and

b) developing recommendations for the future needs of big data, open data etc. supporting various smart cities services.

3.3.5 Communication layer

The standardisation of the following technologies (but not limited to) should be implemented in the communication layer of smart cities:

a) Ethernet;

b) xDigital Subscriber Line (xDSL);

c) Ethernet Passive Optical Network (EPON)/Gigabit Passive Optical Network (GPON);

d) Synchronous Digital Hierarchy (SDH)/Dense Wavelength Division Multiplexing (DWDM)/Optical Transport Network (OTN);

e) Global System for mobile Communications (GSM)/Wideband Code Division Multiple Access (WCDMA) / Code Division Multiple Access (CDMA);

f) Long Term Evolution (LTE) Time Division Duplex (TDD)/Frequency Division Duplex (FDD); and

g) EMF.

3.3.6 Sensing layer

The standardisation of the following technologies (but not limited to) should be implemented in the sensing layer of smart cities:

a) IEEE 1451 smart transducer interface;

b) ISO/IEC JTC 1 SC 31 and AIM PDF417 barcode symbols;

c) ISO/IEC JTC 1 SC 31 and Electronic Product Code (EPC) global radio frequency identification (RFID);

d) ZigBee;

e) IPv6 over low power wireless personal area networks (6LoWPAN);

f) wireless MBus;

g) Global positioning system (GPS);

h) video surveillance; and

i) smart metering.

The tasks include, but are not limited to developing guidelines for:

a) the application of smart transducer interface in smart cities;

b) the interface of barcode symbols in smart cities;

c) the interface of RFID in smart cities;

d) the gateway of ZigBee/6LoWPAN in smart cities;

e) the gateway of wireless MBus;

f) the interface of global positioning system in smart cities;

g) the application of video surveillance in smart cities; and

h) the interface of smart metering with related services in smart cities.

3.4 Buildings and physical infrastructure

3.4.1 Urban planning

The standardisation of the following technologies should be implemented in the urban planning of smart cities:

Building smart cities from an urban planning perspective.

Tasks include but are not limited to:

a) developing guidelines and best practices for urban planning in smart cities; and

b) developing guidelines for the essential technologies for urban planning such as GIS, electronic maps.

3.4.2 Low carbon design and construction

The standardisation of the following areas should be implemented in the low carbon design and construction of smart cities:

a) energy conservation; and

b) waste recycling.

The tasks include, but are not limited to:

a) developing guidelines and best practices for energy conservation in buildings and physical infrastructure; and

b) developing guidelines and best practices for waste recycling in buildings and physical infrastructure.

3.4.3 Intelligent building systems

The standardisation of the following technologies should be implemented in the intelligent building systems of smart cities:

Synergy of intelligent building systems with related information and communication systems in smart cities.

The tasks include, but are not limited to:

a) developing recommendations regarding the interface of intelligent building systems with related information and communication systems in smart cities; and

b) developing guidelines and best practices for the ICT use for intelligent building systems in smart cities.

3.4.4 Building Information Modelling (BIM)

The standardisation of the following areas should be implemented in the building information modelling of smart cities:

Synergy of building information modelling with related information and communications systems in smart cities.
The tasks include, but are not limited to:

a) developing recommendations regarding the interface of building information modelling with related ICT systems in smart cities including GIS, navigation, wireless telecommunication, etc.; and

b) developing guidelines and best practices for the information and communications use for building information modelling in smart cities.

3.4.5 Traffic systems

The tasks include, but are not limited to:

a) developing guidelines for building intelligent transport system in smart cities;

b) developing recommendations and best practices related to the implementation of intelligent transport system with a view to addressing environmental challenges; and

c) providing the necessary collaboration for joint activities in this field between SDOs conducting related work on Intelligent Transportation Systems (ITS).

3.4.6 Urban pipeline network

The standardisation of the following technologies should be implemented in the urban pipeline of smart cities:

a) urban pipeline information; and

b) city geo-information infrastructure.

Urban pipelines are usually considered as the lifeline of cites for piped water, sewage, drainage, sanitation, electricity, heating, telecommunications, gas and waste, etc.

The tasks include, but are not limited to:

a) developing guidelines and best practices for the urban pipeline informatization in smart cities; and

b) developing recommendations for the integrated management of pipeline networks including:

   i) terms and definitions;

   ii) characteristics, high-level requirements and general capabilities;

   iii) information model from spatial-temporal perspective; and

   iv) architecture framework and technical requirements.

There are several technical reports on infrastructure, integrated management, and smart water management in FG-SSC (ITU-T TR infrastructure, ITU-T TR management and ITU-T TR water).

4. Information and communications architecture for smart cities

Previous chapters have described the requirements and standardisation framework for smart city initiative. In this chapter, the framework on information and communication architecture is being discussed in focus. In reference to a document published by ITU entitled “Setting the framework for an ICT architecture of a smart sustainable city”, the information and communication architecture should be seen from several perspectives.

4.1 Physical information and communications perspective

In this document, only the information and communication architecture from the communications perspective is being highlighted. Figure 3 shows a corresponding smart city information and communication architecture emphasizing on the communications perspective.

4.1.1 Sensing layer

This consists of terminal node and capillary network. Terminals (sensor, transducer, actuator, camera, RFID reader, barcode symbols, GPS tracker, etc.) sense the physical world. They provide the superior "environment-detecting" ability and intelligence for monitoring and controlling the physical infrastructure within the city.

The capillary network (including Supervisory Control and Data Acquisition (SCADA), sensor network, Highway Addressable Remote Transducer (HART), WPAN, video surveillance, RFID, GPS related network, etc.) connects various terminals to network layer, providing ubiquitous and omnipotent information and data.

4.1.2 Network layer

The network layer indicates various networks provided by telecommunication operators, as well as other metro networks provided by city stakeholders and/or enterprise private communication network.

4.1.3 Data and support layer

The data and support layer is fundamental in making the city "smarter", with its main purpose is to ensure the support capabilities of various city-level applications and services. Data and support layer contains data center from industries, departments, enterprises, as well as the municipal dynamic data center and data warehouse, among others, established for the realization of data process and application support.

4.1.3 Application layer

The application layer includes various applications that manage the smart city and deliver the smart city services.

4.1.4 Operation, Administration, Maintenance and Provisioning (OAM & P) and security

This provides the operation, administration, maintenance and provisioning, and security function for the information and communication systems of smart cities.

4.2 Interfaces between layers

Six interfaces between layers and OAM & P and security framework, marked with numbers in circles are shown in Figure 3. These are places where communications and exchange of information between the layers, and OAM & P and security framework take place. They are the focal point of standards specifications and thus are called communication interface point. Overall functions at each of these reference points are listed in 4.2.1 until 4.2.6.

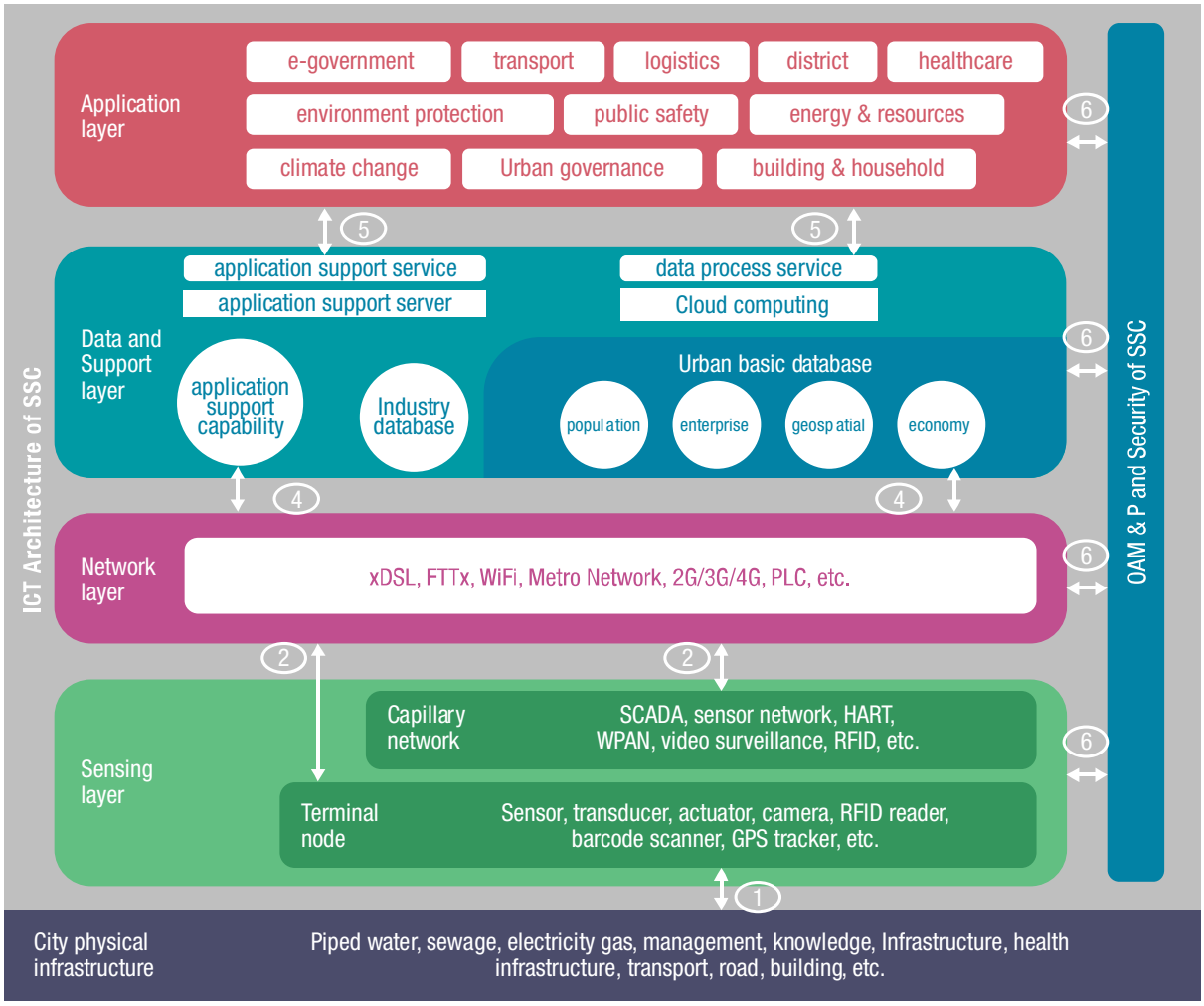

Figure 3. A multi-tier smart cities information and communication architecture from communications view, emphasising on a physical perspective[6]

4.2.1 Communication interface point 1

This exists between the city physical infrastructure and sensing layer. It enables the terminals sense the physical world, i.e. exchange of information and control signals between terminal nodes in sensing layer and the physical infrastructure.

4.2.2 Communication interface point 2

This exists between the terminal nodes in sensing layer and the network layer. In this case terminal nodes, directly or through net gates, access to the network layer without through capillary network.

4.2.3 Communication interface point 3

This exists between the capillary network in sensing layer and the network layer. In this case, capillary networks collect the sensing data, and connects to the communication networks.

[6] ITU-T Technical Reports and Specifications on Smart Sustainable Cities - Setting the framework for an ICT architecture of a smart sustainable city

4.2.4 Communication interface point 4

This exists between the network layer and the data and support layer. It enables communications between data centers and lower layers for collecting various information through the communication networks.

4.2.5 Communication interface point 5

This point exists between the data and support layer and the application layer. It enables data centers and/or application support functionalities providing information to corresponding city applications and services, and also enables integrated applications exchanging data via data centers and/or application support functionalities.

4.2.6 Communication interface point 6

This exists between the OAM & P and security framework and the four layers. It enables the corresponding modules to exchange data flow and control flow and provide operation, administration, maintenance, provisioning and security function.

5. Contacting MCMC and MTSFB

For any enqueries and further information on this frameworks kindly contact:

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Annex A
(Informative)

Relevant organisations/working group

3rd Generation Partnership Project (3GPP)

3rd Generation Partnership Project 2 (3GPP2)

American Society of Civil Engineers (ASCE)

CEN/CENELEC/ETSI, Joint Working Group on Smart Grid

CEN/CENELEC/ETSI, Joint Working Group on Smart Meters

CEN/TC 251, Health informatics

Distributed Management Task Force (DMTF)

Globe Standard 1

Healthcare Level 7 (HL7)

IEC TC 57, Power systems management and associated information exchange

IEC TC 108, Safety of electronic equipment

IEC/SMB SEG 1, Systems Evaluation Group - Smart Cities

ISO Climate Change Coordinating Committee (ISO CCCC)

ISO International Workshop Agreement (IWA), International harmonized method(s) for a coherent quantification of CO2e emissions of freight transport

ISO/IEC JTC 1/SG 1, Information Technology/Smart Cities

ISO/IEC JTC 1/SC 31, Automatic identification and data capture techniques and AIM

ISO/IEC JTC 1/SC 31 and EPC global

ISO/IEC JTC 1/SC 27, Information Technology/Security techniques

ISO/PC 248, Sustainability criteria for bioenergy

ISO/PC 283, Occupational health and safety management systems

ISO/TC 5, Ferrous metal pipes and metallic fittings

ISO/TC 22, Road vehicles

ISO/TC 30, Measurement of fluid flow in closed conduits

ISO/TC 59, Buildings and civil engineering works

ISO/TC 68, Financial services

ISO/TC 85, Nuclear energy, nuclear technologies, and radiological protection

ISO/TC 115, Pumps

ISO/TC 131, Fluid power systems

ISO/TC 138, Plastics pipes, fittings and valves for the transport of fluids

ISO/TC 153, Valves

ISO/TC 163, Thermal performance and energy use in the built environment

ISO/TC 176, Quality management and quality assurance

ISO/TC 180, Solar energy

ISO/TC 204, Intelligent transport systems

ISO/TC 205, Building environment design

ISO/TC 205/WG3, Building environment design/Building Automation and Control System (BACS) Design

ISO/TC 207, Environmental management

ISO/TC 211, Geographic information and Geomatics

ISO/TC 213, Dimensional and geometrical product

ISO/TC 215, Health informatics

ISO/TC 222, Personal financial planning

ISO/TC 223 Societal security

ISO/TC 224, Service activities relating to drinking water supply systems and wastewater systems - Quality criteria of the service and performance indicators

ISO/TC 238, Solid biofuels

ISO/TC 241, Road traffic safety management systems

ISO/TC 242, Energy Management

ISO/TC 255, Biogas

ISO/TC 257, Evaluation of energy savings

ISO/TC 265, Carbon dioxide capture, transportation, and geological storage

ISO/TC 268, Sustainable development in communities

ISO TC 268/SC 1, Sustainable development in communities/Smart community infrastructures

ISO/TC 275, Sludge recovery, recycling, treatment and disposal
ISO/TC 282, Water re-use

ISO/TMB SAG Cities, Strategic Advisory Group on Smart Cities

ITU-T CITS, Collaboration on ITS Communication Standards

ITU-T FG CarCom, Focus Group on From/In/To Cars Communication

ITU-T FG Distraction, Focus Group on Driver Distraction

ITU-T FG DR&NRR, Focus Group on Disaster Relief Systems, Network Resilience and Recovery

ITU-T FG M2M, Focus Group on Machine-to-Machine Service Layer

ITU-T FG Smart Grid, Focus Group on Smart Grid

ITU-T Q12/SG13, Distributed service networking

ITU-T Q25/SG16 IoT application and services

ITU-T Q27/16, Vehicle gateway platform for telecommunication/ITS services /applications

ITU-T Q4c/SG15, PEV communications

ITU-T SG2, Operational aspects of service provision and telecommunications management

ITU-T SG5, Environment and climate change

ITU-T SG13, Future networks, including cloud computing, mobile and next-generation networks

ITU-T SG15, Networks, technologies and infrastructures for transport, access and home

ITU-T SG17, Security.

ITU-T WP3/SG5, ICT and climate change

Network Video Interface Forum

Open Geospatial Consortium (OGC)

Physical Security Interoperability Alliance

Standardization Administration of China (SAC)

SAC/TC426, Digital Technique of Intelligent Building and Residence Community

Special Interest Group for Computer GRAPHICS (SIGGRAPH)

The United Nations Framework Convention on Climate Change (UNFCCC)

World Wide Web Consortium (W3C)

World Health Organisation (WHO)

ZigBee Alliance

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[19] Setting the framework for an ICT architecture of a smart sustainable city

[20] Smart City standardisation framework

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