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TECHNICAL CODE

SMART SUSTAINABLE CITIES - ARCHITECTURE IN RELATIONS TO INFORMATION AND COMMUNICATIONS ASPECTS

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Committee representation

This technical code was developed by Internet of Things (IoT) and Smart Sustainable Cities Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB), which consists of representatives from the following organisations:

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This technical code was also developed in collaboration with National Standards Committee for Smart City on ICT Infrastructure, NSC 27/TC 2.

Foreword

This technical code for Smart Sustainable Cities - Architecture in Relations to Information and Communications Aspects ('Technical Code') was developed pursuant to Section 185 of the Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) by the Internet of Things and Smart Sustainable Cities Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB).

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

SMART SUSTAINABLE CITIES - ARCHITECTURE IN RELATIONS TO INFORMATION AND COMMUNICATIONS ASPECTS

0. Introduction

The main objective of this Technical Code is to provide a working standardisation reference for smart sustainable cities stakeholders to consider. Through this architecture, the complexities of smart sustainable 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 sustainable cities in Malaysia.

The term ‘smart sustainable cities’ is used widely in this Technical Code which also encompasses ‘smart cities’. In some places, where relevant, the term ‘smart cities’ is used.

1. Scope

This Technical Code provides guidance on the information and communications aspect of deploying smart sustainable cities solutions and value creation through data. The aim of this Technical Code is to assist various stakeholders from government and non-government bodies, agencies and organisations, industry and academia in the development and implementation of smart sustainable cities in Malaysia, with a specific focus on the information and communication aspects.

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

MCMC MTSFB TC G004, *Specification for Green Data Centres*

MCMC MTSFB TC G010*, Radiocommunication Network Facilities - Smart Pole*

MCMC MTSFB TC G011, *Radiocommunications Network Facilities - In-Building*

MCMC MTSFB TC G013, *Internet of Things (IoT) - Security Management*

MCMC MTSFB TC G016*, Information and Network Security - Security Posture Assessment (SPA).*

MCMC MTSFB TC G019*, Scheduled Waste Management for Base Station (Inclusive of E-Waste)*

MCMC MTSFB TC G024, *Fixed Network Facilities - In-building and External*

MCMC MTSFB TC G026, *Radiocommunications Network Facilities - Street Furniture*

ISO/IEC JTC 1/SC 31, *Automatic Identification and Data Capture Techniques*

IEEE 1451, *Standards for Smart Transducer Interface*

AIM USS PDF417, *Uniform Symbology Specification - PDF417*

3. Abbreviations

For the purposes of this Technical Code, the following abbreviations apply.

See Annex A.

4. Terms and definitions

For the purposes of this Technical Code, the following terms and definitions apply.

4.1 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, etc.) to be delivered through a variety of medium or to be executed in different platforms (computers, mobile phones, television, etc.).

4.2 Device

With regards to the Internet of Things (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.

4.3 Internet of Things (IoT)

A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving, interoperable ICT.

NOTES:

1. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

2. In a broad perspective, the IoT can be perceived as a vision with technological and societal implications.

4.4 Smart sustainable city

An innovative city that uses Information and Communication Technologies (ICT) 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, as well as cultural aspects.

4.5 Sustainability

State of the global system, including environmental, social, economic and governance aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs.

4.6 Things

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.

4.7 Stakeholders

Any entity, an institution, or an individual, that has an interest in smart sustainable cities or that can significantly influence or be influenced by its deployment.

5. Smart cities

Digital technology advancement has a strong association with economic development, social inclusion and environmental protection. Converged technologies 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.

5.1 Requirements

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

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

These innovation solutions shall 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, service availability and data management.

d) Economy

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

5.2 Information and communications convergence as an enabler for smart sustainable cities

ICT are necessities for smart sustainable 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 communications, 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 catalysts since it has the potential of merging the physical world and the virtual world through providing the inter-networking between devices (e.g. sensors and actuators) that interfaces with physical objects (e.g. vehicles, buildings and other things) with the powerful and disruptive computing world (e.g. the mobile, social, big data, cloud computing, machine intelligence, etc.) by virtue of their

connectivity via the Internet. This leads to scenarios such as intelligent buildings, real time predictive analytics and control, smart manufacturing, autonomous vehicles, personal assistants and robots, high quality speech recognition, etc.

Figure 1 explains how ICT serves as a fundamental base in supporting the smart sustainable cities' vision to increase quality of life by addressing 4 urban dimensions as described previously. This ecosystem is scalable from a micro-level smart lifestyle, in which devices are connected at a personal level. When these devices interact among each other and the surrounding devices, this ecosystem is termed smart sustainable cities and communities. As cities-wide network and devices interact among other cities at a country-wide scale, this ecosystem is termed Smart Nation.

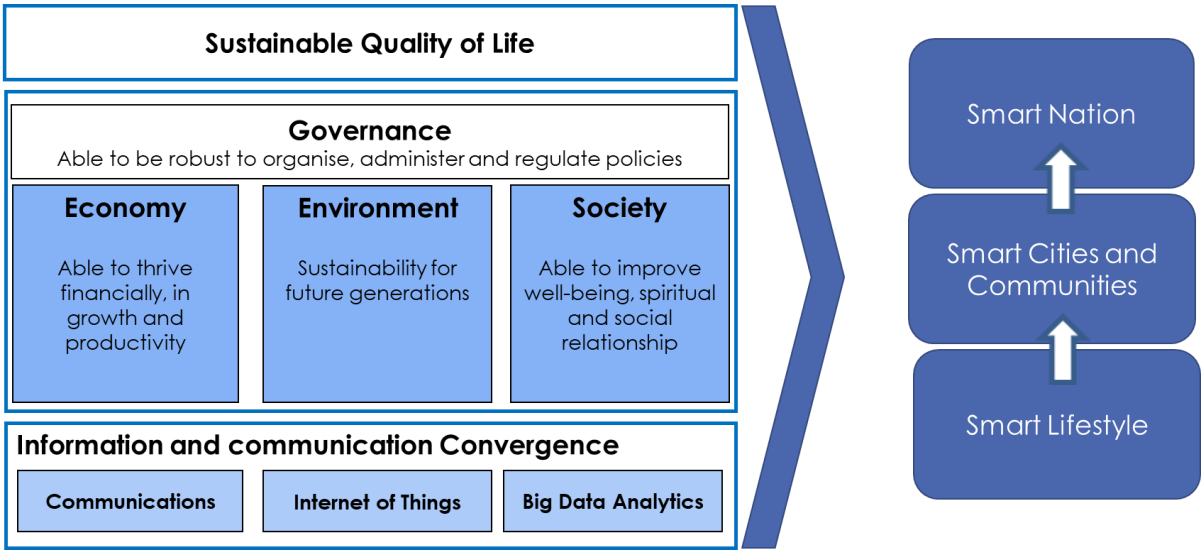

Figure 1. Information and communications convergence as an enabler in supporting smart sustainable city vision

5.3 Infrastructure classifications for smart sustainable cities

Smart cities infrastructure and system 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 or transport, basic amenities, and utilities such as water, waste, energy, internet and broadband connectivity and coverage. Some of the hard infrastructure includes data centres, transport, and access network.

b) Soft infrastructure

This category refers to digital and non-physical aspects of requirements such as human capital, knowledge and Information Technology (IT) literacy, social adaptation and inclusion, privacy and trust, as well as effective policies and planning, data and software.

5.4 Smart sustainable cities stakeholders

The following set of stakeholders has been identified for smart sustainable cities:

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 sustainable 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 sustainable 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) Developers

City and housing developers who are part of the smart city ecosystem.

l) Urban planners

Their expertise is important to better understand how to include ICT into medium and long term city planning, as well as to consider urban complexities.

m) 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.

5.5 Characteristics concerns of smart sustainable cities

The previously identified context regarding requirements, scope and stakeholders illustrate that there is a broad environment where the smart city information and communications architecture shall be applied, which addresses:

a) Different geographic areas and demographics

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.

d) Different timeframes

Time within the smart city information and communication architecture is requested to operate, for example, small communities may change more slowly compared to global cities.

e) Data privacy and protection

City services will need to be careful about collecting data, ensuring that citizens are notified of all data collection and analysis.

f) Business model

In which a city government organises its services to create and deliver value for its citizens in a way that is economically viable, socially inclusive and environmentally sustainable.

5.6 Architecture principle of a smart sustainable cities

The followings are the architectural principles that enable the smart city information and communications 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 include the data and communication layer;

b) Interoperability

Interoperability needs to be ensured among heterogeneous and distributed systems in smart sustainable 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. Smart city architecture and the services should aspire to have a good fault tolerance mechanism;

f) Availability, manageability and resilience

Service availability shall according to the smart city user demand and disaster recovery shall be provided in various levels. Manageability relates to operational concerns in managing the architecture in supporting smart city information and communication operations. In order to allow equipment, networks, and applications to function normally, manageability at the systems/subsystems level shall be secured, especially given that an increasing number of operational processes will be managed automatically;

g) Standards-based

Standards are guide and shall be adopted for ease of deployment, interoperability and future-proof of integration; and

h) Technology and/or vendor independence

Smart sustainable 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.

6. Smart sustainable cities standardisation framework

A smart sustainable cities standardisation framework provides clear demarcation of scopes and use of the standards as illustrated in Figure 2 below.

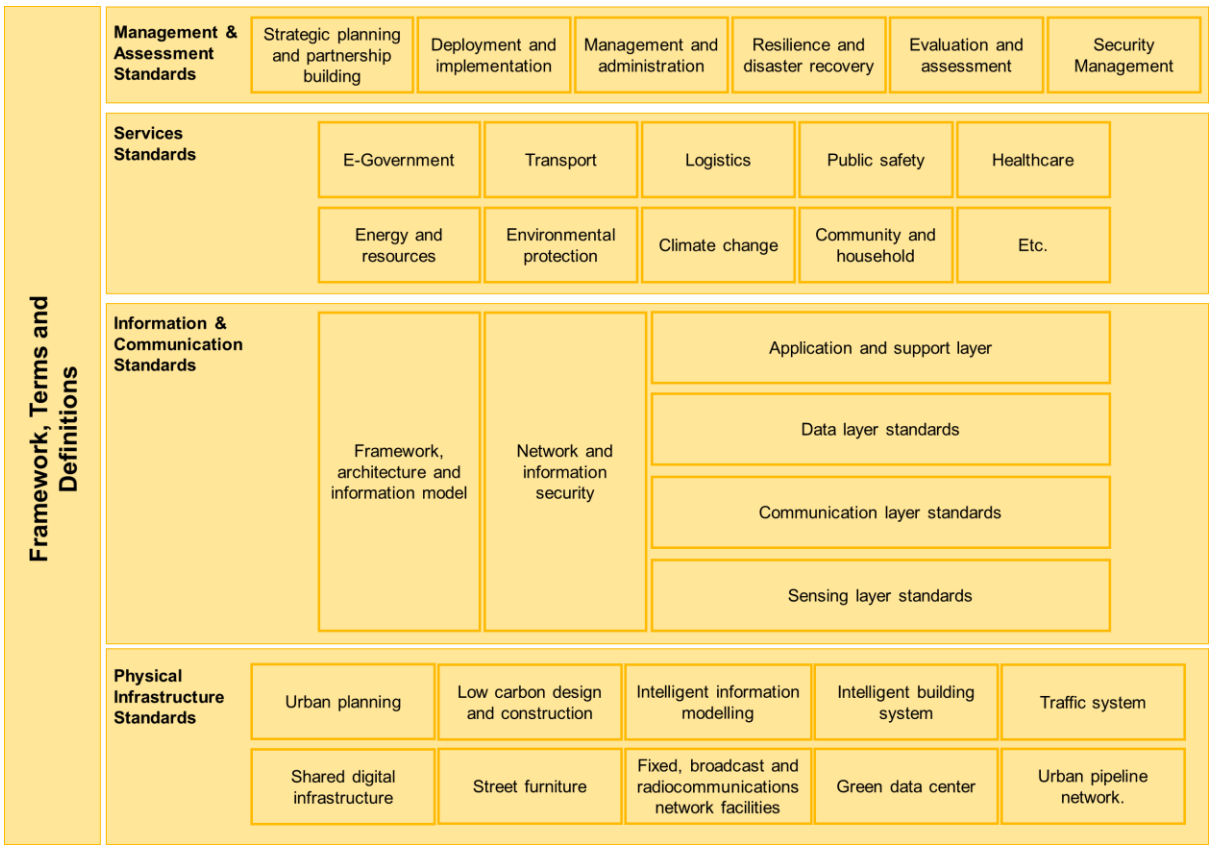

Figure 2. Smart sustainable cities standardisation framework that is widely adopted by international standard development organisations

Standards for smart sustainable cities can be generally classified into four categories as follows.

a) Management and assessment.

b) Smart cities services.

c) Information and communications.

d) Buildings and physical infrastructure.

6.1 Management and assessment

6.1.1 Strategic planning, business model and partnership building

Some of the initiatives and best practices that should be considered under this category includes the following, but not limited to:

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

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

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

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

6.1.2 Deployment and implementation

Guidelines are crucial for the deployment and implementation in smart sustainable cities. Some of the guidelines that should be considered includes the following, but not limited to:

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

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

6.1.3 Management and administration

The management and administration code of conducts include the following, but not limited to:

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

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

6.1.4 Resilience and disaster recovery

It is a process of helping smart sustainable cities to be better prepared to withstand and rapidly recover from disasters. Proper guidelines in this aspect include the following, but not limited to:

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

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

6.1.5 Evaluation and assessment

There are several technical report and technical specifications on key performance indicators of information and communications technologies for smart sustainable cities.

Smart sustainable cities shall consider using a methodology of evaluation and assessment for smart sustainable cities including developing smart cities indicators and smart cities ICT indicators that will provide the readiness level and identify area of improvements.

6.1.6 Security Management

Security management for smart cities shall be developed for each layer, which requires different standards and implementation. It includes the following components.

a) Application layer.

b) Service support and application layer.

c) Network layer.

d) Device layer.

e) Management capabilities.

f) Security capabilities.

The example of security requirements should be referred to MCMC MTSFB TC G013.

6.2 Smart cities services

Smart cities services provide streamlined ways to meet the challenges of mobility, public services, and safety while promoting sustainability. The services provided shall cater for the cities' need and may differ from a city to another.

6.2.1 E-government

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

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

b) 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 sustainable cities; and

c) digital smart services including digital IDs and integration with e-government services

6.2.2 Transport

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

The services of the 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. It should have the following, but not limited to:

a) guidelines for integrated services within smart sustainable cities Intelligent Transport Systems (ITS);

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

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

d) public transport lines equipped with publicly accessible real-time information system.

6.2.3 Logistics

The standardisation of logistics in smart sustainable cities should fulfil the service requirements related to consignor, consignee, carriers, goods and warehouses. It should have the following, but not limited to:

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

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

6.2.4 Public safety

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

The services of public safety for smart sustainable cities include, but are not limited to crime reduction, tackling natural and man-made disasters, and emergency response. It should have the following, but not limited to:

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

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

c) guidelines on the use of technologies such as Closed-Circuit Television (CCTV) and drones in cities with emphasis on the security and privacy of the citizens.

6.2.5 Health care

The standardisation of health care in smart sustainable 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. It should have the following, but not limited to:

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

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

c) guidelines for the strategy of improving resident health such as mitigation of exposure to the Electromagnetic Field (EMF), noise, pollution, etc.

6.2.6 Governance of urban infrastructure

The standardisation of the governance of urban infrastructure in smart sustainable 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. It should have the following, but not limited to:

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

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

c) recommendations for integrated management in smart sustainable cities (high level requirements, framework, metamodel, data fusion, management services, cooperation in creation of infrastructure, sharing among service providers, etc.).

6.2.7 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 resource management in smart sustainable cities.

The energy and resource management includes, but is not limited to power supply, water supply and sanitation, oil supply, gas supply, and city minerals. It should have the following, but not limited to:

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

b) guidelines for resource supervision in smart sustainable cities;

c) guidelines for energy efficiency in smart sustainable cities; and

d) recommendations for methodology of energy evaluation in buildings.

To achieve such energy and resource management requirements, it is recommended that buildings in smart cities should be designed (or retrofitted), assessed and rated as Green Buildings. To this end, there are several Green Building Index (GBI) technical documents that are available for use. In general, the assessment criteria will cover 6 categories as below.

a) Energy Efficiency (EE).

b) Indoor Environment Quality (EQ).

c) Sustainable Site Planning and Management (SM).

d) Materials and Resources (MR).

e) Water Efficiency (WE).

f) Innovation (IN).

There are several design reference guides and submission format for green building index practices.

6.2.8 Environmental protection (sustainability)

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

The services of environmental protection include but not limited to EMF, solid waste management, e-waste management, pollution source monitoring, toxic substance monitoring, water pollution monitoring and noise monitoring. It should have the following, but not limited to:

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

b) guidelines for exposure to environmental pollution (EMF, chemicals, radiation, noise, air quality, etc.).

6.2.9 Climate change adaptation

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

The services of information and communication, and climate change for smart sustainable cities include but are not limited to tackling climate change in cities. It should have the following, but not limited to:

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

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

c) guidelines for the use of ICT aligned to Sustainable Development Goals (SDG).

6.2.10 Community and household

Standardisation related to districts should fulfil the service requirements of residents, and communities in smart sustainable cities. It should have the following, but not limited to:

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

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

6.2.11 Smart pole

A smart pole refers to a network facility that is primarily used as a radiocommunication structure with other ancillary services that include street lighting and data collection sensor.

Standardisation related to districts should fulfil the service requirements of residents, and communities in smart sustainable cities. It should have the following, but not limited to:

a) requirements and the Operations and Maintenance (O&M) of smart pole for base station sites;

b) requirements and engineering practices necessary for the safe and proper implementation of smart pole;

c) design concepts and methodologies used in construction of smart pole which include structural, mechanical, and electrical works; and

d) standards for the installation of new smart pole.

The requirements for smart pole should be referred to MCMC MTSFB TC G010.

6.2.12 Scheduled Waste Management

Waste management is a required service in a city that includes waste collection, transportation, disposal and recycling. It should have the following, but not limited to:

a) guidelines for Scheduled Waste (SW) for smart sustainable cities;

b) guidelines for asset management;

c) standard operating procedures of SW management; and

d) guidelines for waste storage, disposal and recycling.

The requirements for scheduled waste management for base station should be referred to MCMC MTSFB TC G019.

6.3 Information and communications

6.3.1 Information and communication framework, architecture and information model

The standardisation of a smart sustainable cities framework, architecture and information model should be based on an expansion of the related information and communication standards, supporting the development of smart sustainable cities. It should have the following, but not limited to:

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

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

c) information model of smart sustainable cities from a spatio-temporal perspective;

d) information and communication infrastructure or services available in smart sustainable cities or architecture framework and technical requirements of smart sustainable cities; and

e) 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.

6.3.2 Network and information security, availability and resilience

The standardisation of network and information security should be based on and expanding the related information and communication standards, supporting the security requirements of smart sustainable cities including Security Posture Assessment (SPA).

SPA is a cyber security assessment programme that is specifically developed to provide a structured security risk and vulnerability assessment approach and methodology to support the SPA objectives.

It should have the following, but not limited to:

a) supporting organisations to conduct effective, value for money security testing and assessment as part of the technical security assurance framework. It is designed to enable the organisations to prepare for the security testing, conduct actual testing in a consistent, competent manner and follow-up tests effectively.

b) Providing an overview of the key concepts the organisations need to understand in order to conduct a well-managed SPA programme, the evaluation criteria and the process to employ an external security assessor in supporting the SPA programme.

The requirements for security posture assessment should be referred to MCMC MTSFB TC G016.

6.3.3 Application and support layer

Application and support layer consist of Service-Oriented Architecture (SOA), information presence, integrated management and decision-making. It should have the following, but not limited to:

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

b) guidelines for Three Dimensional (3D) virtual reality of smart sustainable cities, city simulation, web services for smart sustainable cities, etc.

6.3.4 Data layer

The standardisation of technologies such as cloud computing, data exchange and Geographic Information System (GIS) should be implemented in the data layer of smart sustainable cities. It should have the following, but not limited to:

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

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

6.3.5 Communication layer

The standardisation of the following technologies but not limited to should be implemented, where required, in the communication layer of smart sustainable cities.

a) Ethernet.

b) xDigital Subscriber Line (xDSL).

c) Ethernet Passive Optical Network (EPON) or 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).

g) EMF.

6.3.6 Sensing layer

There are various sensing technologies that can be implemented in smart sustainable cities depending on the use cases. The system should support both proprietary and open standards. Some of the sensing technologies include the following, but not limited to:

a) IEEE 1451;

b) ISO/IEC JTC 1/SC 31;

c) AIM USS PDF417;

d) Electronic Product Code (EPC) global Radio Frequency Identification (RFID);

e) ZigBee;

f) IPv6 over Low Power Wireless Personal Area Networks (6LoWPAN);

g) wireless M-Bus;

h) Global Positioning System (GPS);

i) video surveillance; and

j) smart metering.

6.4 Buildings and physical infrastructure

6.4.1 Urban planning

The standardisation of the following technologies should be implemented in the urban planning of smart sustainable cities, but not limited to:

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

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

6.4.2 Low carbon activities

The standardisation on low carbon such as energy conservation and waste recycling should be implemented in the low carbon design and construction of smart sustainable cities. It includes the following but not limited to:

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

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

6.4.3 Intelligent building systems

Synergy of intelligent building systems with related information and communication systems in smart sustainable cities can be implemented. The standards include the following, but not limited to:

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

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

6.4.4 Building Information Modelling (BIM)

The standards include the following, but not limited to:

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

b) guidelines and best practices for the information and communications used for BIM in smart sustainable cities.

6.4.5 Traffic systems

Standards related to traffic systems include the following but not limited to:

a) guidelines for building ITS in smart sustainable cities; and

b) recommendations and best practices related to the implementation of ITS with a view to addressing environmental challenges.

6.4.6 Urban pipeline network

Urban pipelines are usually considered as the lifeline of cites for piped water, sewage, drainage, sanitation, electricity, heating, telecommunications, gas, waste, etc. Standards related to urban pipeline networks include the following, but not limited to:

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

b) 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 a spatial-temporal perspective; and

   iv) architecture framework and technical requirements.

6.4.7 Street furniture

This Technical Code is required to enhance the network coverage and capacity at street level and in preparation for any future technologies.

a) technical requirements for the installation of radiocommunications network facilities on new, existing or replacement structure of street furniture;

b) design concepts used in the construction of street furniture for integration with radiocommunications network facilities, which include structural, mechanical and electrical works; and

c) safety requirements at sites during and after installation of radiocommunications network facilities on new, existing or replacement structure of street furniture

The requirements for street furniture should be referred to MCMC MTSFB TC G026.

6.4.8 Fixed network facilities - in-building and external

This Technical Code is intended as a reference for architects, consulting engineers, owners, property developers and others who are responsible for planning and erecting buildings. This is in line with the objective to meet the requirements of end users for fixed communications services with minimum disruptions to all services offered by the service providers.

The standardisation of the following technologies but not limited to should be implemented in the In-Building and External of smart sustainable cities:

a) in-building and external fixed network facilities for Single Dwelling Unit (SDU), Multi-Dwelling Unit (MDU) and campus type.

b) fixed network facilities include all infrastructure and cablings required for fixed network services.

c) meet the requirements of end users for fixed communications services with minimum disruptions to all services offered by the service providers.

The requirements for fixed network facilities should be referred to MCMC MTSFB TC G024.

6.4.9 Radiocommunications network facilities - in building

The standardisation of the following technologies should be implemented in the in-building radiocommunication network facilities of smart sustainable cities:

a) Civil Mechanical and Electrical (CME)

   Consists of CME requirements for in-building wireless system, backhaul, GPS, mobile and WiFi;

b) In-Building Coverage (IBC) Distributed Antenna System (DAS)

Consists of requirements for Radio Frequency (RF) material, RF distribution design and RF distribution Key Performance Indicator (KPI);

c) Quality of Service (QoS) and Service Level Agreement (SLA)

Consists of requirements on QoS and SLA for an in-building wireless system; and

d) Responsibility matrix

Consist of responsibility party to provide in-building wireless system.

The requirements for in-building coverage should be referred to MCMC MTSFB TC G011.

6.4.10 Radiocommunications network facilities - minor communications infrastructure

This Technical Code will ensure the effective, efficient and suitable provision of communications network facilities so that it achieves social, environmental and economic sustainability. It includes the following:

a) provisions of Minor Communications Infrastructure (MCI) which incorporates the facilities contained in the *Garis Panduan Perancangan Infrastruktur Komunikasi (GPP-I)* and provides for the development of further communications facilities that comply with the developments;

b) principles for the design, siting, construction and operation of communications facilities that apply to all proposed MCI; and

c) information to assist the relevant stakeholders to understand the planning and legislative requirements for communications facilities.

The requirements for MCI should be referred to MCMC MTSFB TC G035.

6.4.11 Green data centre

The standardisation of the following technologies, but not limited to, should be implemented in the green data centre of smart sustainable cities:

a) policies, systems and processes to improve the energy efficiency of data centres and at the same time reduce the carbon footprint of the industry; and

b) guidelines on operation of data centres including environmental conditions, energy management, air management, cooling management, IT equipment and lighting, power chain management, space management, information management, and governance.

The specification of green data centre should be referred to MCMC MTSFB TC G004.

7. Information and communications architecture for smart cities

This clause focuses on the framework on information and communication architecture.

7.1 Physical information and communications perspective

This sub-clause described the information and communication architecture from the communications perspective is being highlighted. Figure 3 shows a corresponding smart cities information and communication architecture emphasising the communications perspective. The architecture provides some examples, but not limited to.

7.1.1 Sensing layer

This consists of a 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), video surveillance, RFID, GPS related network, etc.) connects various terminals to network layer, providing ubiquitous and omnipotent information and data.

7.1.2 Other data sources

There are 2 categories of data sources besides the sensor data, which are static and dynamic. Static data sources present data related to land use, drainage, water barriers, buildings, roads, amenities, and others. Dynamic data sources present historical data, weather and other data during the intended period.

7.1.3 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 networks. This includes, but not limited to, 2G, LTE, 5G, WiFi, xDSL, FTTx, LoRa, Sigfox and any other connectivity network that are being used now and in the future. The use of the network depends on the smart cities use cases.

7.1.4 Data and support layer

The data and support layer are fundamental in making the city 'smarter', with its main purpose is to ensure the support capabilities of various city-level applications and services. The data and support layer includes data centre from industries, departments, enterprises, as well as the municipal dynamic data centre and data warehouse, among others, established for the realisation of data process and application support. This layer consists of the following, but not limited to:

a) smart cities platform that aggregates data from multiple sources; and

b) data processing service that processes data from various sources. It includes data filtering, data transformation and data analytics. This component is usually part of the smart cities platform.

7.1.5 Application layer

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

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

This provides the Operation, Administration, Maintenance and Provisioning (OAM & P) and security functions for the information and communication systems of smart sustainable cities.

7.2 Interfaces between layers

Seven 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 from 7.2.1 to 7.2.7.

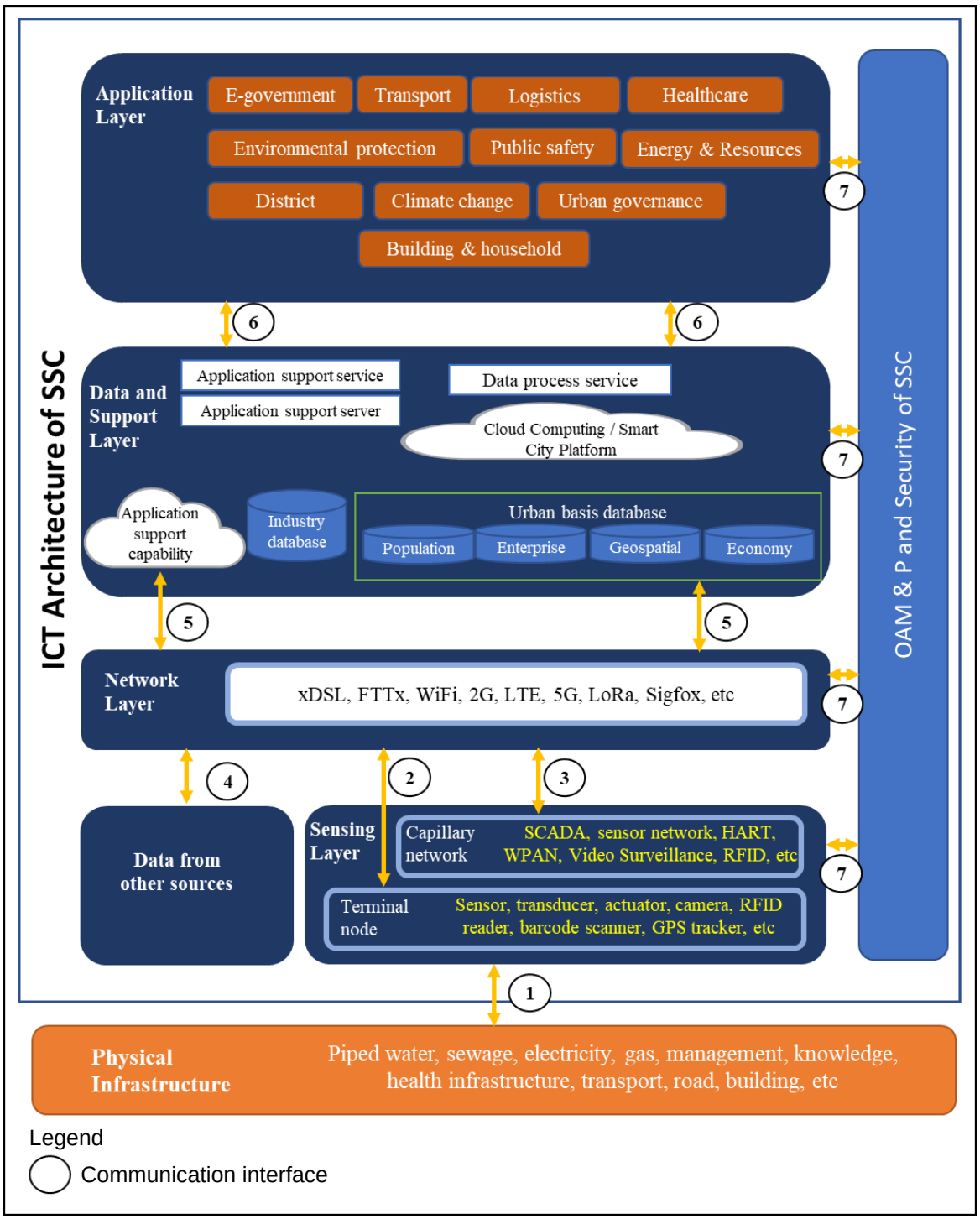

Figure 3. A multi-tier smart sustainable cities information and communication architecture from communications view, emphasising on a physical perspective

7.2.1 Communication interface point 1

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

7.2.2 Communication interface point 2

This exists between the terminal nodes in the sensing layer and the network layer. In this case, terminal nodes have access to the network layer without through capillary network either directly or through some devices.

7.2.3 Communication interface point 3

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

7.2.4 Communication interface point 4

This exists between the other data sources and the network layer. The data in this interface is from other sources than the sensing layer. It could be existing data or from third parties.

7.2.5 Communication interface point 5

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

7.2.6 Communication interface point 6

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

7.2.7 Communication interface point 7

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 OAM & P and security function.

Annex A
(informative)

Abbreviations

2G	Second Generation
5G	Fifth Generation
3D	Three Dimensional
6LoWPAN	IPv6 over Low Power Wireless Personal Area Networks
BIM	Building Information Modelling
CCTV	Closed-Circuit Television
CDMA	Code Division Multiple Access
CME	Civil Mechanical and Electrical
DAS	Distributed Antenna System
DWDM	Dense Wavelength Division Multiplexing
EE	Energy Efficient
EMF	Electromagnetic Field
EPC	Electronic Product Code
EPON	Ethernet Passive Optical Network
EQ	Environment Quality
FDD	Frequency Division Duplex
FTTx	Fiber To The x
GBI	Green Building Index
GHG	Green House Gas
GIS	Geographic Information System
GPON	Gigabit Passive Optical Network
GPS	Global Positioning System
GSM	Global System for Mobile communications
HART	Highway Addressable Remote Transducer
IBC	In-Building Coverage
ICT	Information and Communication Technologies
IN	Innovation
IoT	Internet of Things
IT	Information Technology
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LTE	Long Term Evolution

LoRa	Long Range
M-Bus	Meter Bus
MCI	Minor Communications Infrastructure
MDU	Multi-Dwelling Unit
MR	Materials and Resources
NGO	Non-Government Organisation
O&M	Operations and Maintenance
OAM & P	Operation, Administration, Maintenance and Provisioning
OTN	Optical Transport Network
QoS	Quality of Service
RF	Radio Frequency
RFID	Radio Frequency Identification
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goals
SDH	Synchronous Digital Hierarchy
SDU	Single Dwelling Unit
SLA	Service Level Agreement
SM	Sustainable Site Planning and Management
SOA	Service-Oriented Architecture
SPA	Security Posture Assessment
SW	Scheduled Waste
TDD	Time Division Duplex
V2I	Vehicle to Infrastructure
V2V	Vehicle to Vehicle
V2X	Vehicle to Everything
WCDMA	Wideband Code Division Multiple Access
WE	Water Efficiency
WiFi	Wireless Fidelity
xDSL	xDigital Subscriber Line

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