

TECHNICAL REFERENCE

# Sensor network for smart nation (public areas)



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## Foreword

This Technical Reference was prepared by the Sensor Networks Working Group (SNWG) of the Internet of Things Technical Committee (IoT TC), under the direction of the IT Standards Committee (ITSC). The ITSC endorsed the TR on 23 October 2014. Acknowledgement is made to the Working Group and Technical Committee members who contributed to the development of the Technical Reference.

According to ISO/IEC 29182-2[4], sensor networks are systems of spatially distributed sensor nodes interacting with each other and, depending on applications, possibly with other infrastructure in order to acquire, process, transfer, and provide information extracted from its environment with a primary function of information gathering and possible control capability. Broadly, sensor networks can be classified into 2 categories. In the first category, sensors or sensor nodes are densely deployed in a mesh formation with multi-hop radio connectivity in an outdoor environment. Environment monitoring and control systems typically belong to this category. The other kind of sensor networks generally employs star-based topology with single hop radio connectivity in a more confined environment. Home and building control systems are examples of sensor networks in this category.

With Singapore's Smart Nation initiative, sensor networks of the first category are expected to be widely deployed across the island in public areas. The scalability of these public-area sensor networks however, is adversely impacted by the absence of standards that address system architecture, as well as the security concerns in deploying such networks.

The implications of sensor networks for public areas are not fully understood as it involves multi-disciplinary expertise. Sensor networks for public areas will need to evolve and develop as public agencies and industries gain experience.

This Technical Reference is not to be regarded as a Singapore Standard. A Technical Reference is normally made available for provisional application over a period of two years, but does not have the status of a Singapore Standard. However, this Technical Reference is expected to evolve with time and may be revised earlier than the typical two-year review period.

The experience gained during the application will be used to modify the Technical Reference so that it can be adopted as a Singapore Standard. Users of the Technical Reference are invited to comment on its technical content, ease of use and any ambiguities or anomalies. These comments can be submitted using the feedback form provided at the end of the Technical Reference and will be taken into account in the review of the publication. At a suitable time, the Technical Reference will be reviewed by the WG to discuss the comments received and to determine its suitability as a Singapore Standard. Submission for approval by the Standards Council as a Singapore Standard will be carried out only upon agreement after review.

This Technical Reference is expected to be used by system integrators, technology developers and service providers.

In preparing this Technical Reference, reference was made to the following publications:

- 1) ISO/IEC 29182-1:2013 Information technology – Sensor networks: Sensor Network Reference Architecture (SNRA) – General overview and requirements
- 2) ISO/IEC 29182-2:2013 'Information technology – Sensor networks: Sensor Network Reference Architecture (SNRA) – Vocabulary and terminology', for which Clause 3 of this Technical Reference is largely based on.
- 3) ISO/IEC 29182-3:2014 Information technology – Sensor networks: Sensor Network Reference Architecture (SNRA) – Reference architecture views

- 4) IEEE 802.15.4-2011 Low-Rate Wireless Personal Area Networks (LR-WPANs), Table 58
- 5) Bluetooth Core Specification 4.0 information on Security Modes

Acknowledgement is made for the use of the above publications.

Attention is drawn to the possibility that some of the elements of this Technical Reference may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

## Technical Reference for sensor network for smart nation (public areas)

### 0 Introduction

#### 0.1 Smart nation vision

Singapore is implementing a bold plan to be the world's first smart nation to improve peoples' lives. Singapore hopes to pioneer a new technology industry in smart nation capabilities, nurture creative talents in data and analytics, and aid development of impactful applications of disruptive technologies ranging from smart robotics, Internet-of-Things (IoT) to big data, cloud computing, etc. It is also integrating concerted efforts in data governance, protection and sharing, as well as in cyber-security. Its end goals are to build an anticipatory government, provide an array of city services, and empower its citizens with rich data insights to improve lives. It is doing so by leveraging on its effective and open access fibre network to homes and offices, and by expanding the intelligent infrastructure to street level coverage with new Aggregation Gateway Boxes (AG Boxes) for an integrated sensor-rich network, together with a new Smart Nation Operating System. At the same time, it is exploring a new Heterogeneous Network (HetNet) across fixed and mobile infrastructures.

As shown in Figure 1, potential themes of smart nation are:

- Integrated city planning – enrich living experience and determine precise locations where amenities are needed by using geospatial analytics;
- Integrated public services – provide one-stop service with anticipatory and interconnected infrastructure;
- Healthcare – enable tele-monitoring and tele-rehab services;
- Safety and security – provide non-intrusive, real-time smart monitoring system;
- Urban mobility – enable development of innovative mobile solution to optimise travel experience;
- Urban living – build connected homes, leveraging smart home technologies.

A critical role of Information and Communication Technology (ICT) standards is to enable the integration and interoperability of different ICT systems that support the Smart Nation initiatives and facilitate the optimal use of resources across these systems in order to provide value, to Singapore as a whole and to each individual citizen.

#### 0.2 Objectives

Sensor networks are one of the key technologies that support Singapore's vision to be a smart nation. They provide us the means to gain better awareness of our surroundings, through the data collected through a mesh of sensors deployed, to make decisions in real time as events or emergencies occur, or develop appropriate systems that result in more responsive, anticipatory services for the citizens.

To realise the smart nation vision, it is anticipated that sensors will be densely deployed in large quantities in Singapore. However, in the market today, there are many vendors producing sensor devices that employ different technologies and standards for various purposes, such as sensing temperature, pressure, light, or humidity. As such, interoperability across different sensor networks, and even between sensors in the same network, becomes a big challenge operationally.

The objective of this Technical Reference is to provide guidance on the communication and interface standards to:

- improve the interoperability of sensor networks for public areas;
- promote sharing of sensing data;
- reduce cost of deploying sensor applications;
- ease the development of innovative applications utilising sensor data.

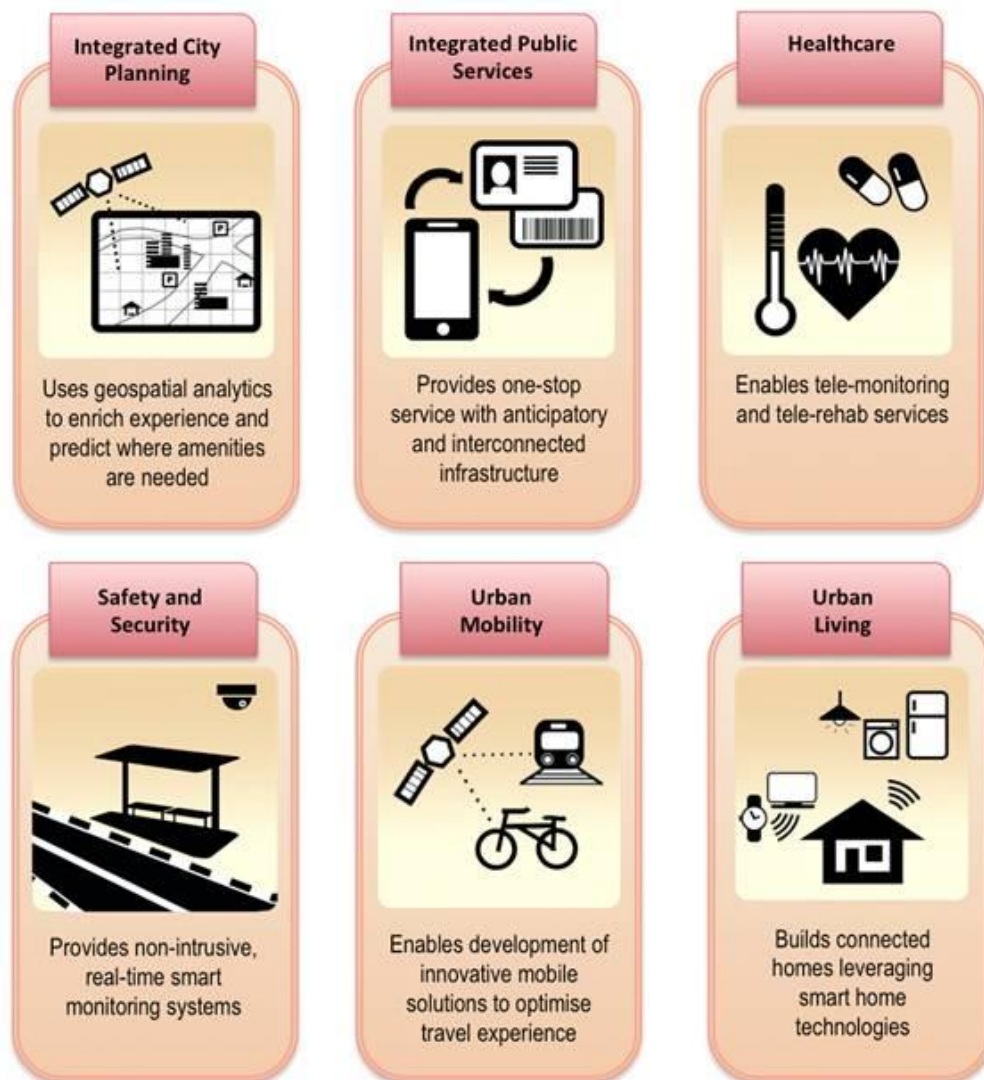


Figure 1 – Smart nation possibilities



## 1 Scope

This Technical Reference provides guidance on the communication and application interface standards for the development and deployment of sensor network(s) for public areas in Singapore.

In the context of this Technical Reference, public areas refer to any place (open to the air or otherwise) to which members of the public have access, e.g. roads, pavements, parks and waterways. Areas in commercial and residential buildings are excluded from this Technical Reference.

## 2 Normative references

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

BBF TR-069	CPE WAN Management Protocol, Broadband Forum
Core Version 4.0	Bluetooth Core Specification Version 4.0
ECMA 404, Oct 2013	The JSON Data Interchange Format
IEEE 802.11	Information technology – Telecommunications and information exchange between systems Local and metropolitan area networks– Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
IEEE 802.15.4-2011	Local and metropolitan area networks – Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs)
IETF RFC 3411-3418	Simple Network Management Protocol (SNMP) version 3
IETF RFC 6120	Extensible Messaging and Presence Protocol (XMPP): Core
IETF RFC 7252 (June 2014)	The Constrained Application Protocol (CoAP)
ISO/IEC 29182-1:2013	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 1: General overview and requirements
ISO/IEC 29182-2:2013	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 2: Vocabulary and terminology
ISO/IEC 29182-3:2014	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 3: Reference architecture views
ISO/IEC 29182-4:2013	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 4: Entity models
ISO/IEC 29182-5:2013	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 5: Interface definitions
ISO/IEC 29182-7:2014	Information technology – Sensor network : Sensor network reference architecture (SNRA) – Part 7: Interoperability guidelines
OASIS MQTT v3.1.1	OASIS MQ Telemetry Transport (MQTT) v3.1.1 Protocol Specification
OGC SWE	Open Geospatial Consortium (OGC) Sensor Web Enablement framework standards

OMA Device Management 2.0	Open Mobile Alliance (OMA) Device Management Protocol v2.0
OMA Lightweight M2M (LWM2M) v1.0	Open Mobile Alliance Lightweight Machine to Machine Technical Specification
ONVIF	Open Network Video Interface Forum (ONVIF) Network Interface Specification
OPC UA	OPC Unified Architecture specification IEC/TR 62541 Part 1 and 2 (2010) IEC 62541 Part 3-8 (2011)
PSIA	Physical Security Interoperability Alliance (PSIA) specifications
W3C EXI Recommendation 11, Feb 2014	Efficient XML Interchange (EXI) Format, 1.0 (Second Edition)