Singapore Standards Council

**TR 50 : 2016**

(ICS 35.110; 35.240.01)

**TECHNICAL REFERENCE**

# IoT information and services interoperability for Smart Nation

Published by

Enterprise Singapore

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(ICS 35.110; 35.240.01)

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ISBN 978-981-4726-39-9

First published, 2016

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## Foreword

This Technical Reference (TR) was prepared by the Information and Services Interoperability Working Group of the Internet of Things (IoT) Technical Committee, under the direction of the IT Standards Committee (ITSC). The ITSC endorsed the TR on 28 March 2016.

This TR was developed to facilitate the sharing of IoT data and information across multiple industry applications, so as to support Singapore's Smart Nation vision. It aims to achieve this by providing design considerations and recommendations for common interface standards applicable for cross-domain applications and nation-wide deployments.

This TR is a provisional standard made available for application over a period of two years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the two years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable.

NOTE – Due to changes in the industry landscape, this TR may be revised earlier than the typical two-year review period if deemed necessary.

This TR will help to:

– promote discovery of sensing data, sensor networks and instrumentation;

– enable the sharing of sensing data, sensor networks and instrumentation;

– ease the development of distributed, interoperable and innovative solutions; and

– reduce cost of deployment, operation and maintenance of IoT solutions.

Ultimately, the TR will help to lower the entry barriers for technopreneurs, and stimulate and foster innovative business models in the ecosystem.

This TR can be used by:

- agencies who want to deploy a common infrastructure for IoT solutions or create IoT solutions based on a common IoT infrastructure;

- system integrators and service providers who need to design, implement and deploy a common infrastructure for IoT solutions or create IoT solutions based on a common IoT infrastructure;

- developers and vendors who want to develop innovative cross-domain products and solutions;

- researchers and analysts who want to access and/or share sensing data for analysis, simulation and forecasting purposes;

- citizens who want to access and/or share sensing data and solutions.

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

1) ISO/IEC 29182-2:2013 Information technology – Sensor networks: Sensor Network Reference Architecture (SNRA) - Part 2: Vocabulary and terminology

2) ISO/IEC 2382:2015 Information technology – Vocabulary

Some terms in Clause 3 of this TR are based on the above publications and are reproduced with the permission of the International Organization for Standardization.

Acknowledgement is made for the use of information from the above publications.

# Technical Reference for IoT information and services interoperability for Smart Nation

## 0 Introduction

### 0.1 Vision of a Smart Nation

Singapore has embarked on a plan to become the world's first smart nation. This initiative aims to harness the power of networks, data and infocomm technologies to improve the quality of life of its citizens and to create more business opportunities for its enterprises.

At the same time, connected devices such as smartphones, fitness trackers and remote health monitoring devices have continued to grow explosively as the Internet of Things (IoT) connects ever more devices.

As the number of connected devices increases, devices, systems and services from different organisations shall have some manner of interoperability between themselves for a true IoT to occur. Smart Nation is made up of both legacy systems and new projects from different domains. Standards play a critical role in enabling the interconnectivity of these legacy and green-field systems and the sharing of data and information among these systems.

### 0.2 Standards for Smart Nation

This Technical Reference (TR) is part of the series of IoT and sensor network standards developed to support the Smart Nation initiative.

The standards for Smart Nation are clustered into three groups as follows:

– Standards for sensor networks that aim to provide recommendations on the communication and application interface standards for the development and deployment of sensor network(s) for different environmental settings. The settings include, but are not limited to public areas and homes.

– Standards for IoT (foundational) that provide information on basic building blocks which aid the development of cross-domain IoT systems for sharing information and the use of instrumentation. This TR is one of such standards.

– Standards for domain-specific applications (Internet of Things) that focus on specific vertical domains such as healthcare and intelligent transportation.

Two TRs on sensor networks for Smart Nation have already been developed:

– TR 38 : 2014 Sensor network for Smart Nation (public areas)

– TR 40 : 2015 Sensor networks for Smart Nation (homes)

The recommendations in this TR expand on and are consistent with those from TR 38 on sensor networks for public areas and TR 40 on sensor networks for homes. This TR supports the Smart Nation vision, by enabling the sharing of sensing data and meaningful data. It can be the catalyst for innovation and mass adoption of IoT solutions by enabling:

– a variety of data to be collected and combined, which enables insights into patterns (e.g. vital signs, consumption, usage, social, activity, environmental, etc.) and their consequences at a nation-wide level;

– contextual information to be derived at the individual level. By applying inferences on the patterns and contextual information, personalised recommendations can be made and timely preventive measures taken;

– timely and efficient data collection and the taking of appropriate actions based on the data received, while scalable to a nation-wide level;

– efficient usage and management of scarce resources (e.g. road, energy, environment, healthcare, manpower, etc.).

## 1 Scope

This TR recommends a minimum set of coherent international or industry standards for interface interoperability of information and services that supports a variety of applications across multiple industries and are suitable for deployment on a nation-wide scale.

Annex A provides a non-exhaustive list of reference applications and their categories. Annex B and Annex C demonstrate a simplified implementation and some deployment possibilities respectively, based on a selection of recommendations in this TR.

The TR does not:

– attempt to improve or to address differences in existing standards;

– cover security and IT enterprise standards, standards for the management of sensor networks, and standards beyond the scope of IoT;

– recommend standards that are domain, industry or sector specific.

The TR is not exhaustive in the recommendation of relevant standards and is not a functional specification of the IoT platform for Smart Nation.

## 2 References

The following documents are recommendations for the application of this TR:

| | |
|---|---|
| IETF RFC 7159 | The JavaScript Object Notation (JSON) Data Interchange Format |
| IETF RFC 6120 | Extensible Messaging and Presence Protocol (XMPP): Core |
| IETF RFC 6690 | Constrained RESTful Environments (CoRE) Link Format |
| IETF RFC 7252 | The Constrained Application Protocol (CoAP) |
| IETF Internet-Draft | Media Types for Sensor Markup Language (SenML) |
| ISO/IEC 20922 (OASIS MQTT) | Information Technology -- Message Queuing Telemetry Transport (MQTT) v3.1.1 |
| OGC O&M (ISO 19156: 2011) | Observations and Measurements (O&M) |
| OGC SensorML | Sensor Model Language (SensorML) |
| OGC SWE | Sensor Web Enablement (SWE) |

| | |
|---|---|
| OGC STA | SensorThings API (STA) |
| OMA LWM2M | Lightweight Machine to Machine (LWM2M) Technical Specification |
| OMG DDS | Data Distribution Service (DDS) |
| TR 38 : 2014 | Sensor network for Smart Nation (public areas) |
| TR 40 : 2015 | Sensor networks for Smart Nation (homes) |
| W3C HTTP | Hypertext Transfer Protocol (HTTP) |
| W3C HTTPS | Hypertext Transfer Protocol Secure (HTTPS) |
| W3C JSON-LD | A JSON-based Serialization for Linked Data (JSON-LD) |
| W3C LDP | Linked Data Platform (LDP) |
| W3C OWL | Web Ontology Language (OWL) |
| W3C RDF | Resource Description Framework (RDF) |
| W3C SPARQL | SPARQL Protocol and RDF Query Language |
| W3C SSN | Semantic Sensor Network Ontology |
| W3C XLink | XML Linking Language (XLink) |
| W3C XML | Extensible Markup Language (XML) |