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Information technology — Sensor network testing framework

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Foreword

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The committee responsible for this document is ISO/IEC JTC 1, *Information technology*.

Introduction

Sensor network is widely used around the world in multiple fields such as industrial automation, environment monitoring, smart home, intelligent health-care and smart grid. The applications can involve different devices supplied by different manufacturers, e.g. sensors, actuators, controllers, routers and gateways, etc. Data can be collected and processed by use of different wired/wireless communication technologies. Thus, various test systems should be employed to satisfy some specific requirements. The operations of test systems is a challenge to users, if without a uniform test platform.

When designing and developing a sensor network test system, the characteristics regarding the following aspects should be considered:

a) Sensor network heterogeneity. It is necessary to verify the interoperability of sensor networks based on different protocols prior to system application;

b) Diversity of sensor network applications.

However, an international test standard for sensor networks which can provide guidance to design and develop a uniform platform integrating different tests for sensor networks is still unavailable.

Information technology — Sensor network testing framework

1 Scope

This document specifies:

— testing framework for conformance test for heterogeneous sensor networks,

— generic services between test manager (TMR) and test agent (TA) in the testing framework, and

— guidance for creating testing platform and enabling the test of different sensor network protocols.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
analysis module
logical unit within a testing application process which is used to analyse the information from test agent and module-based test depending on a particular strategy

3.2
test agent
device designed for different sensor network protocols or various kinds of hardware that can communicate directly with the test manager and the systems under test

3.3
testing application process
software functional entity that performs the processing by combining test modules, analysis modules and report modules to fulfil test purposes

Note 1 to entry: It is an application platform that supervises various operational aspects of testing activities and entities, usually through interaction with test agents.

3.4
test module
logical unit within a testing application process that performs operations depending on a specified testing requirements

3.5
testing platform
testing entity that could integrate different test systems for different protocols and technologies

EXAMPLE A platform can provide IPv4 and IPv6 conformance testing systems.

3.6
test report
logical unit of software within a testing application process that produces documents at the end of test assessment

3.7
view object
logical element provided to support efficient access to data within a testing or analysis module

Note 1 to entry: It is visible on graphic user interfaces.

4 Abbreviated terms

TE	auxiliary testing equipment
DUT	device under test
ICS	implementation conformance statement
IUT	implementation under test
MIB	management information base
OD	object dictionary
SAPs	service access points
SNTF	sensor network testing framework
SUT	system under test
TA	test agent
TAP	testing application process
TDSs	testing data services
TM	test module
TMR	test manager
TMSs	testing management services
TP	test purpose
VO	view object

5 Overview of a sensor network testing framework (SNTF)

5.1 Testing requirements of sensor networks

Varied with applications, sensor networks are likely employ different communication technologies and protocols. To ensure their interconnection and operation, it is required to deploy a great number of test systems, which are designed to test individual technologies and protocols with regard to protocol conformance. Therefore, it is a challenging task to integrate the variety of the test systems for sensor networks.

It is difficult to manage different test systems, make them work together and execute test cross various technologies and protocols for specific user requirements. Various application systems need different communication interfaces and protocols, which can't interact directly with each other.

With changing testing requirements, test system for sensor networks should be scalable and adaptable on demand. For example, when new sensor networks are added into the application, the corresponding test systems should be integrated into the test platform with low costs.

Annex A describes an example of a testing platform for hybrid sensor networks based on IPv6.

5.2 Conceptual model of SNTF

Figure 1 shows the concept model of SNTF. The framework consists of three parts: test manager (TMR), test agent (TA) and system under test (SUT). As an actual management controller, the TMR conducts a test indirectly by controlling the TA. The test activities of the TMR should be converted into unified services and transferred to the TA. After having processed the testing services from TMR, TA conducts test interactions directly with SUT. Therefore, TA bridges TMR and SUT while TA needs to be equipped with the specific physical communication interface and protocol stack as in SUT.

The SUT is a system that can include only one device under test (DUT), or a DUT and some other devices used to activate the behaviours of the specific protocol residing in DUT, which is named auxiliary testing equipment (ATE). DUT needs to be verified for having certain required protocol implementations. SUT contains points of control and observation at the upper or lower service boundary of the protocol implementations that resides in DUT to execute tests. The protocol implementations during testing is called implementations under test (IUT). Before starting performing the conformance tests, IUT should be configured by instructions from TMR. In a complicated environment, ATE can be used to stimulate the DUTs to ensure TAs observe the expected responses from DUT if the IUT can't activate some particular behaviours of protocol by itself.

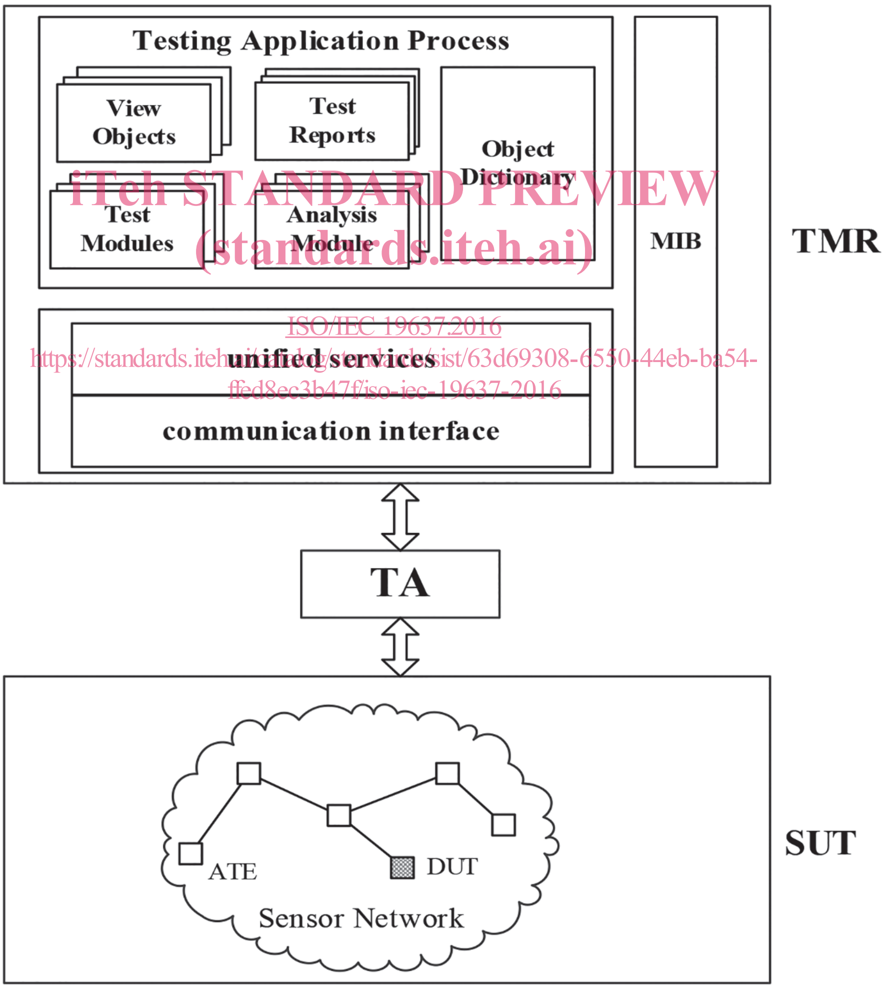

Figure 1 — Conceptual model of SNTF

5.3 Description of test manager (TMR)

The TMR can support several testing application processes (TAP). Each TAP has a specific test task to be performed. For example, it can create an application process for conformance testing of a particular protocol, and simultaneously another application process for a different protocol.

The testing application process is designed on a component basis. There are five types of components in a TAP:

— view object,

— test report,

— test module,

— analysis module, and

— object dictionary (OD).

Figure 2 shows the relationship of the five components.

The test module (TM) is the performer of test cases. Before executing a test, TM should be parameterized to configure the test type for a specific protocol. If the corresponding testing requirements and testing suits are inputted into a TM, it is instantiated. After the TM is started, the steps defined by test cases is executed.

The analysis module (AM) shall connect test modules to collect data to analysis test activities. It is needed to configure the corresponding report format in the AM before producing test reports. Moreover, AM can also collect the information of the operating conditions of the TM.

The view object (VO) has parameter sets from the TMs and AMs. VO can be selected for graphical user interfaces, which allows monitoring the real-time throughput during a certain period. VOs also can be grouped to monitor the parameters in the relevant TMs and AMs; its visual parameters can also be derived from different TMs or AMs.

Management information base (MIB) stores all object values of test module, view object and test report in TMR, including the management objects for TA. The values of the objects in testing application process can be indexed quickly from object dictionary (OD).

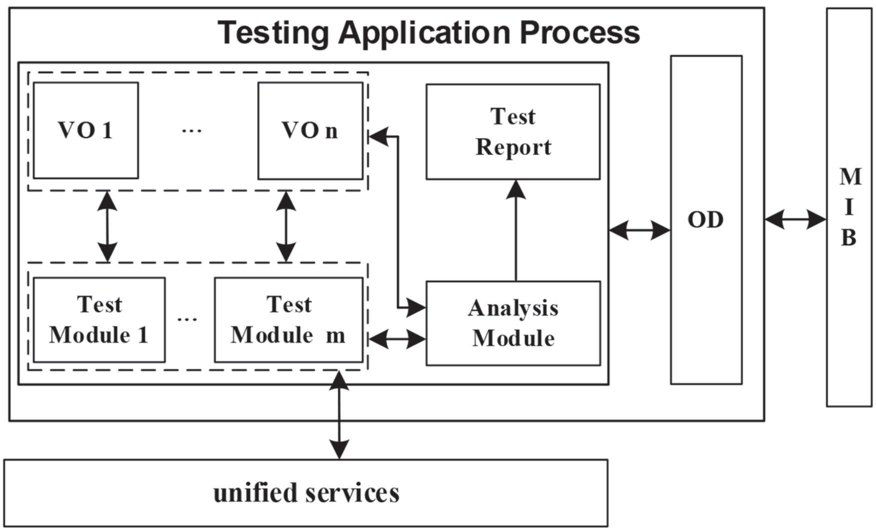

Figure 2 — Relationship of components in TAP

5.4 Description of test agent (TA)

A test agent (TA) is designed for individual protocol, and it can support multiple implementations of the same protocol. The TA handles any direct communications with the SUT with the same protocol through the test driver. Platform independence can be achieved by the test driver. The configuration parameters of test driver are defined in the TA description.

Before performing the corresponding test operations, TA shall establish communication connection with TM in TMR when receiving the start command from a TM. TA receives services from TM and translates them into the appropriate messages in conformance with the protocol of SUT. Structure model of TA is shown in Figure 3.

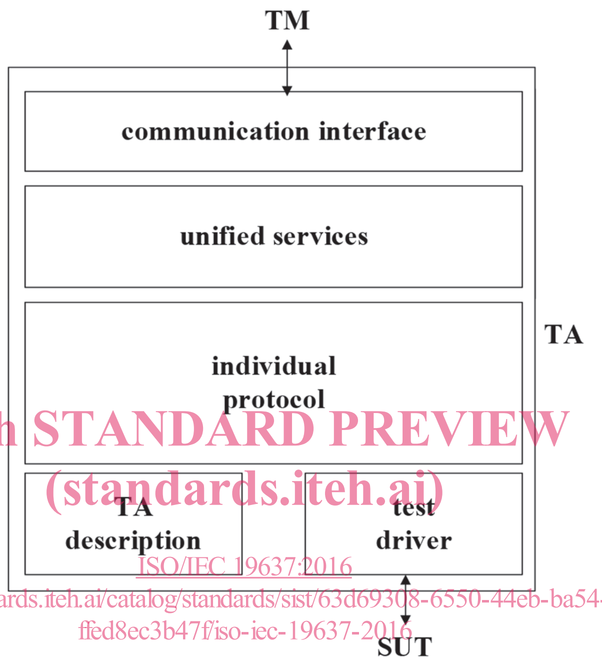

Figure 3 — Structure of TA

6 Testing services

6.1 General

Testing services are conceptually divided into two classes: testing data services (TDSs) and testing management services (TMSs) as shown in Figure 4. TMSs could be used to create application communication relationships or set the parameters of TA via Management Entry-Service Access Points (ME-SAPs). TDSs should be used to implement testing procedures between TMR and TA via Data Entry-Service Access Points (DE-SAPs). TMR can transfer testing data to TA and control TA testing behaviours.

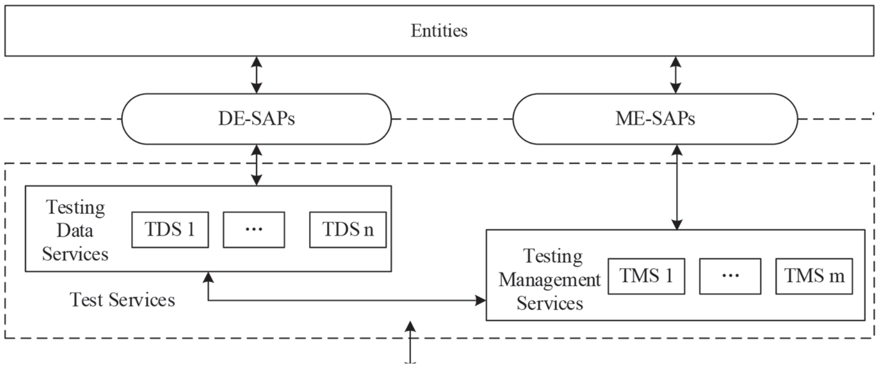

Figure 4 — Overview of test services for sensor networks

TDSs includes:

— EventReport service: This service is used to report one or more failures or exceptions from TAs. The content of the report can be generated dependent on changes of the test condition. EventReport service can be retried until an EventAck service for the EventReport received.

— EventAck service: EventAck is used to acknowledge an individual EventReport service has been received. An EventAck should result in the ceasing of the EventReport retry requests for the corresponding individual event.

— Read service: This service is used to read value of an object from TM in TMR or TA.

— Write service: This service is used to write value of an object from TM in TMR or TA.

— StartTest service: This service is used to start a test task between TM in TMA and TA. Test cases are executed after this service is called.

— StopTest service: This service is used to stop a test task between TM in TMR and TA. All test activities in test system is stopped after this service is called.

— DataUploading service: This service is used to transfer a block of data from TA to TM in TMA. It supports fragmentation to transmit a large amount of data. The destination device can reassemble the received messages.

— DataDownloading service: This service is the same way as the DataUploading service. The difference is that TM sends a block of data to TA.

— StartDownAndUploading service: This service is used to begin downloading or uploading of data.

— StopDownAndUploading service: This service is used to end downloading or uploading of data.

— ExecuteTesting service: This service is used to execute a test case.

TMSs includes:

— Associate service: This service provides mechanisms to create a logical connection between TA and TM in TMR. The connection is the prerequisite for the execution of the other services between TM and TAs.

— Abort service: This service permits to release a logic connection between TM and TAs. Communication activities including should be stopped until a new connection has been established.

— Sync service: The service enables setting of the time for a TA associated with a TM in TMR. This is useful for time synchronization in a test system with time constraints.

— AddressAllocation service: This service provides functions to allocate addresses for TAs. TM can allocate a unique identification for each TA through this service.

— DeviceStatus service: This service is used for a spontaneous transmission of device status.

6.2 Module interactions through unified services

Before testing the SUT, a TM in TMR should create a communication connection with TA and SUT. As shown in Figure 5, the TM sends an associate request message to open a connection for a specific protocol conformance testing. The messages between TM and TA should use the same protocol. Then, TA loads a specific individual protocol and test driver for a specific protocol used in SUT. TA acts as a protocol translator between TM and SUT. When TM intends to terminate the communication activities, it should initiate an Abort service request to TA. If it receives an Abort response from TA, the connection is released successfully.

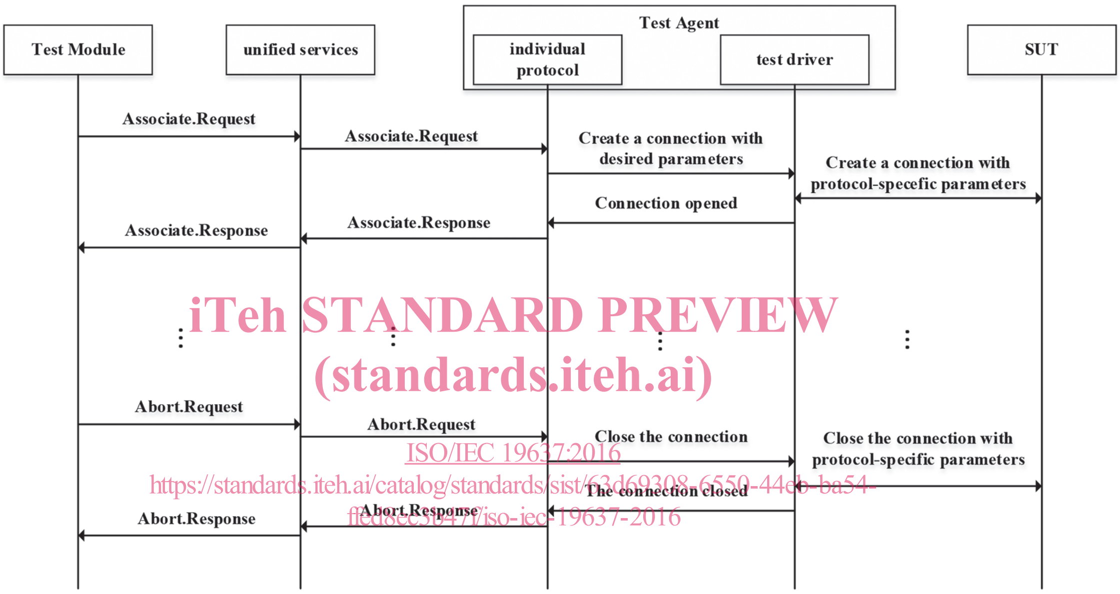

Figure 5 — Sequence diagram of creating and releasing a connection

StartTest service is used to launch a test task after a connection is opened. TA and SUT should allocate the testing resources and provide necessary testing configurations to prepare for testing activities. Test cases in a test suit shall be performed when TA receives ExceuteTesting request. The test results are transmitted to TM. If an analysis module (AM) is configured by the test application process to associate a TA, it should also receive the test results for analysis. When a test task is completed, TM sends a StopTest to end a task. A typed sequence diagram of the messages among modules is shown in Figure 6.

