

IEEE Standard for Design Criteria of Integrated Sensor-Based Test Applications for Household Appliances

IEEE Computer Society
and
IEEE Instrumentation and Measurement Society

Sponsored by the
Test Technology Committee
and
TC-9—Sensor Technology Committee

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Abstract: An integrated framework of the test software for household appliances is defined. This standard specifies the test environment and the test information as well as the means to acquire the information (either Web services or a data-exchange file).

Keywords: household appliances test, IEEE 1851, sensor data, Web service, XML schema

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Introduction

This introduction is not part of IEEE Std 1851-2012, IEEE Standard for Design Criteria of Integrated Sensor-Based Test Applications for Household Appliances.

Quality control is an essential part throughout the household appliance manufacturing process. The appliance manufacturer performs various tests for the household appliances. Most of the tests are completed by the test systems in multiple test laboratories distributed over a wide geographic area. The test systems include three parts: instruments equipped with sensors, computers, and sensor-based test application. The test application part is responsible for automatically collecting, managing, analyzing, and presenting the data for the users, which is viewed as the backbone of the test systems.

Due to the lack of the development criterion of test applications for household appliances, there exist many problems, such as integration problems, reusability problems of software module, systems interoperability problems, and exchange problems of test electronic documents. Specifically, for some government supervision departments, it affects the supervision efficiency due to multiple data formats, multiple test types, diverse measurement systems, and limited human resources. For the product manufacturing enterprises, it leads to low measurement and management efficiency. For the test software development corporations, it brings low development efficiency, huge costs, long cycles, and waste of manpower resources. This document provides the standard format of testing data of household appliances, which makes it easier for users from different enterprises, including product supervisors of government, to read and exploit such kinds of data. This standard also provides the system framework and a set of Web services like testing data transforming and transferring, which are the basis for software engineers to develop integrated testing applications. This standard plays a very important role in improving the supervising efficiency of government departments, the quality management efficiency of the manufacturing enterprises, and the test software development efficiency of software development corporations.

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1. Overview

This standard was developed to serve as a design criteria for integrated sensor-based test applications for household appliances. It specifies the system integration framework, describes test information format, and provides two means to acquire the information via Web service interfaces and data-exchange files.

1.1 Scope

This standard defines the integrated framework of the test software for household appliances oriented to the data from intelligent sensors, including system framework, interfaces of Web services, and data exchange formats, which can be divided as: (1) The system framework to integrate the distributed test applications; (2) The description of appliance test environment and test information, including the metadata of the whole test application, the metadata of the appliance to be tested, the metadata of the sensors, and the sensor data; (3) The file format of test data to be exchanged among distributed test applications; (4) The Web services to transform and transfer monitored data.

1.2 Purpose

This standard defines the file format of test data from household appliances and the Web services that enable the exchange of such test data. Implementation of this standard solves the interoperability and

integration problems for building test applications for household appliances as well as the problems related to the exchange of test data.

1.3 Users

Anticipated users of the standard include the following:

- a) Household appliance test application developer
- b) Household appliance research and development staff
- c) Household appliance testing laboratory assistant
- d) Household appliance enterprise manager
- e) Government quality control staff

1.4 Conventions used within this document

This standard presents an integrated framework of the test application for household appliances, specifying test environment and test information.

This standard uses the vocabulary and definitions of relevant IEEE standards. In case of conflict of definitions, except for those portions quoted from standards, the following precedence shall be observed: (1) Clause 2, (2) Annex C, and (3) the *IEEE Standards Dictionary Online*. The format and terminology standards follow *IEEE Standards Style Manual* [B1].¹

2. Definitions, acronyms, and abbreviations

2.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.²

element: A bounded component of the logical structure of an eXtensible Markup Language (XML) document that has a type and that may have XML attributes and content.

NOTE—Adapted from W3C[®] Recommendation [B7]).^{3, 4}

eXtensible Markup Language (XML) attribute: Name-value pair associated with an XML element.

input item: A set of items whose contents are the metadata that describe an appliance.

¹ The numbers in brackets correspond to those of the bibliography in Annex C.

² *IEEE Standards Dictionary Online* subscription is available at http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

³ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

⁴ W3C is a registered trademark of the World Wide Web Consortium (registered in numerous countries). Marks of W3C are registered and held by its host institutions: Massachusetts Institute of Technology (MIT), European Research Consortium for Information and Mathematics (ERCIM), and Keio University, Japan.

key parameter: A predefined set of keywords, each of which represents one type of information whose value is measured by physical sensors or calculated by specific algorithms or computations.

laboratory: A room or building where household appliances are tested.

relative time: The time (in units of seconds) in reference to the start of a test.

sensor: A concept that refers to physical sensors or logical sensors that reflect the performance of appliances. Physical sensors measure the physical properties of appliances and logical sensors are defined based on physical sensors.

sensor data: A collection of structural data, each of which contains sensor identifier (ID) and measurement data of one sensor.

sensor group: A logical entity that contains a set of sensors with the same sensor type, in which maximum, minimum and average values of this group can be calculated.

sensor identifier (ID): The identifier of a sensor in a test unit.

sensor metadata: The information related to sensors and groups defined in a household appliance test.

sensor type: Category of sensors that share common characteristics.

test capacity: The number of test units in one laboratory.

test data: A collection of structural data, each of which contains time stamp and sensor data.

test environment: The overall information about one laboratory, which mainly consists of test unit navigation and test unit information.

test information: The data produced in one test for one appliance over a period of time, including test metadata, sensor metadata, and test data.

test metadata: The information that describes test data generated by one test, in which the product information is also contained.

test system: A measurement system consisting of instruments, computer, and test applications.

test unit: A physical entity that is built to test one appliance. It contains a collection of sensors connected with instruments. One test unit corresponds to one appliance.

test unit navigation: A navigation tree that is used to access a test unit.

time stamp: The time when the sensor data are collected. It shall be in relative time form.

2.2 Acronyms and abbreviations

CDL	Common Data Language
HTTP	Hyper Text Transport Protocol
netCDF	Network Common Data Format
SOA	Service-Oriented Architecture
URL	Uniform Resource Locator

UTF-8	8-bit Unicode Transformation Format
XML	eXtensible Markup Language

3. System framework

3.1 Architecture

A system framework is a conceptual model in which existing heterogeneous test systems shall be integrated seamlessly ([B1] Guo et al.). The implementation of system framework achieves the aim of standardized data access across various types of laboratories, secure data aggregation across household appliance enterprises, and uniform user operations. Some of characteristics of the system framework are as follows:

- *Interoperability and ease of integration.* Various distributed and heterogeneous test systems can be integrated seamlessly based on Web services. Furthermore, test data from different household appliance enterprises can be processed in a standard way.
- *Scalability.* The framework is scalable to integrate the increased number of test systems. A test system shall be added or removed by either registering or unregistering at the registration center.
- *Uniformity.* A uniform software user interface shall be achieved based on system integration. Users may pay more attention to product testing without worrying about the problems caused by diverse software operations and interfaces.

The system framework shall be divided into three application levels corresponding to laboratory, enterprise, and supervisor of government. Figure 1 shows the whole system architecture and specifies the parts that need to be standardized. The most basic one is the laboratory-level application. High-level applications are based on low-level applications. Applications at each level meet different user requirements and have their own characteristics.

Laboratory-level applications are responsible for collecting data from instruments and presenting it to users. These applications aim at one of various tests and are operated by laboratory assistants. Generally they work in the local test laboratory. A typical test laboratory for household appliances follows the below topology: a number of instruments are connected to a data collection PC using standard communication interfaces; each instrument is equipped with many sensors; several sensors [e.g., temperature (T), voltage (V), electrical energy (E), power (P)] constitute a test unit, as illustrated in Figure 2. One test unit corresponds to one appliance and is used to monitor the appliance's status. Enterprise managers take charge of checking the product testing of the whole enterprise and need to know the product testing status and results of each test laboratory. Due to the heterogeneous local laboratory-level testing applications, enterprise managers have to travel across multiple test laboratories distributed over a wide range of areas, which degrades product test efficiency and increases test expense severely.

Enterprise-level applications, developed by adopting Service-Oriented Architecture (SOA), are built for solving the heterogeneity problem. Various laboratory-level applications are integrated based on Web services. Typical enterprise-level application comprises the service provider, service register, and service consumer. The service provider publishes the test environment information (shown in 4.1) and test information (shown in 4.2) according to the standard. The service register provides the registration information of the test system. The service provider registers its published Web service to the service registry, and the registry information required is shown in Table 1. Laboratory-level applications often serve as service provider, while enterprise-level applications are regarded as service consumer. Enterprise-level applications mainly focus on the basic test environment and test information (described in Clause 4) rather than specified data format of each laboratory-level application. To protect commercial profits, enterprise-level applications usually run in internal network.

Supervisor-level applications facilitate supervisory inspections. It is not viable to provide open access of test information based on Web services since the government supervision network is isolated with the enterprise intranet in most situations. In this case, data files are adopted to enable government inspections. The information in relation to inspections is converted into a set of files and transferred to supervisory institutions. The format of data files is standardized so that they are able to be decoded correctly.

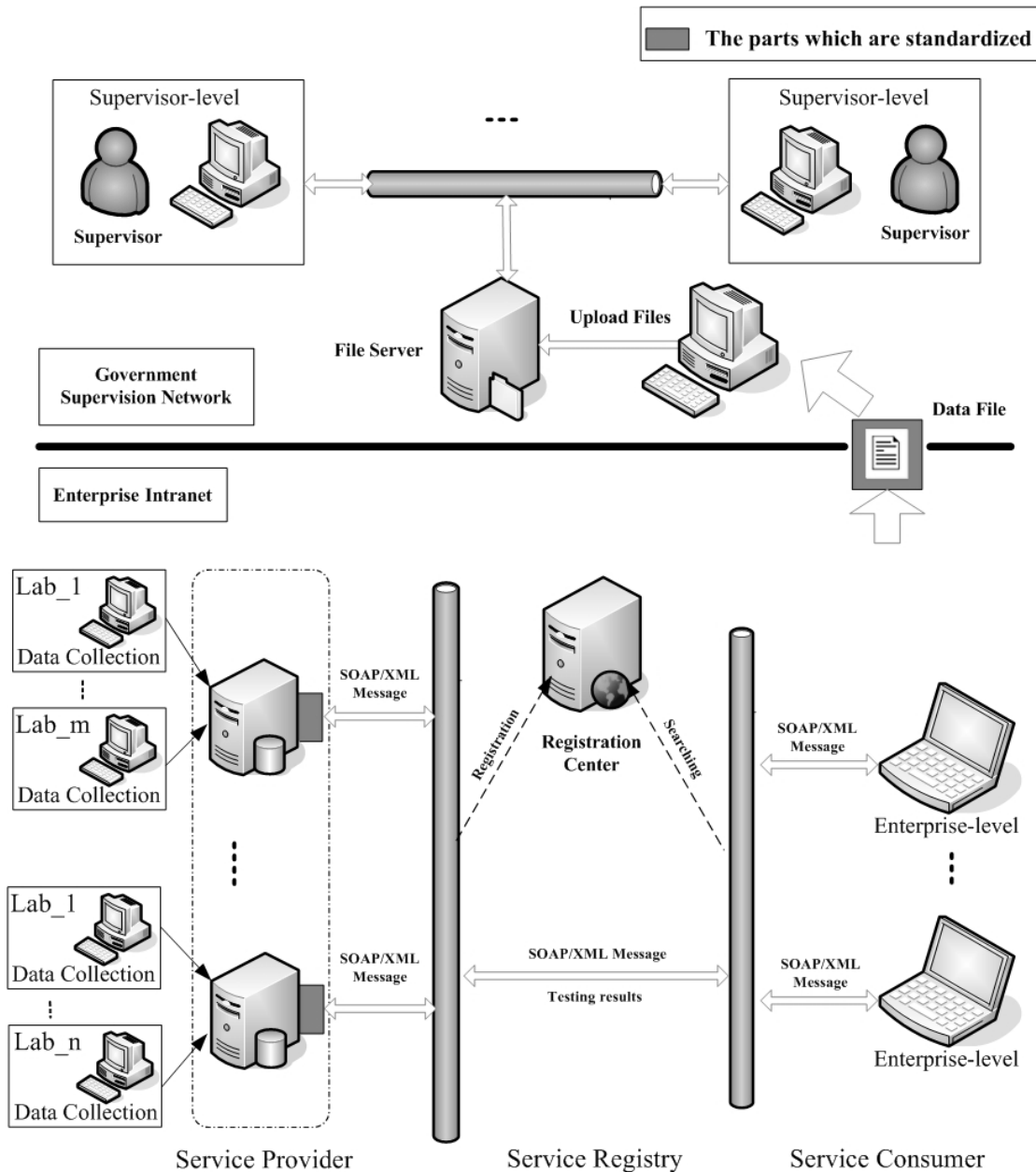


Figure 1—System framework