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SERIES Y: GLOBAL INFORMATION
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS
AND NEXT-GENERATION NETWORKS, INTERNET OF
THINGS AND SMART CITIES

Internet of things and smart cities and communities –
Frameworks, architectures and protocols

Adaptive software framework for Internet of things devices

Recommendation ITU-T Y.4453

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Recommendation ITU-T Y.4453

Adaptive software framework for Internet of things devices

Summary

Recommendation ITU-T Y.4453 addresses the concept of the adaptive software framework (ASF), identifies high-level requirements and provides a reference functional architecture for Internet of things (IoT) devices. The ASF is a framework to manage and control adaptive IoT applications in real-time and in a dynamic way and enables optimal quality of service (QoS) performance. The adaptive IoT application is an IoT application that changes performance by altering system resource allocation (e.g., the number of central processing unit (CPU) cores, graphics processing unit (GPU) utilization, network bandwidth, etc.). Therefore, the ASF can provide optimal working of applications on IoT devices. The ASF is based on the IoT reference model described in Recommendation ITU-T Y.4000.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Adaptive software framework, Internet of things, IoT.

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Recommendation ITU-T Y.4453

Adaptive software framework for Internet of things devices

1 Scope

This Recommendation describes the high-level requirements and functional architecture of the adaptive software framework (ASF) for Internet of things (IoT) devices.

In particular, the scope of this Recommendation includes:

- an overview of the ASF;
- features and high-level requirements of the ASF: monitoring capability, policy decision capability and management capability;
- functional architecture of the ASF: application monitoring manager function, system information manager function and policy manager function.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [b-ITU-T Y.2091]: A structured set of capabilities, which provide value-added functionality supported by one or more services, which may be supported by an API interface.

3.1.2 Internet of things (IoT) [ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 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.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 adaptive software framework: Middleware used to enable optimal QoS performance for each adaptive IoT application by using static/dynamic information regarding applications and system resources in IoT devices.

3.2.2 adaptive IoT application: A special IoT application working in the ASF. The application's performance is changed by altering system resource allocation (e.g., the number of CPU cores, GPU utilization, network bandwidth).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AP	Access Point
API	Application Programming Interface
ASF	Adaptive Software Framework
CPU	Central Processing Unit
DVFS	Dynamic Voltage/Frequency Scaling
FE	Functional Entity
GPU	Graphics Processing Unit
ICT	Information Communication Technology
IoT	Internet of Things
IP	Internet Protocol
IPC	Inter-Process Communication
OS	Operating System
PID	Process Identification
QoS	Quality of Service
STB	Set-Top-Box
TCP	Transmission Control Protocol

5 Conventions

The following conventions are used in this Recommendation:

- The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.
- The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

6 Overview of the adaptive software framework

With the rapid development of Internet of things (IoT) technologies, a large number of different IoT devices are entering the market. Usually, these IoT devices have varying hardware and software capabilities; therefore typical IoT applications need to be modified or customized to meet these diverse capabilities. It is necessary to manage and control these IoT applications to address this issue. The adaptive software framework (ASF) can manage and control adaptive IoT applications in real-time and in a dynamic way to enable optimal QoS performance. A conceptual diagram of the ASF consists of the IoT application layer, the adaptive software framework layer and the system resource layer, as shown in Figure 6-1. The ASF layer exists between the application layer and the system resource layer. The ASF performs monitoring for application and system monitoring, application and system management and analysis and policy decision-making.

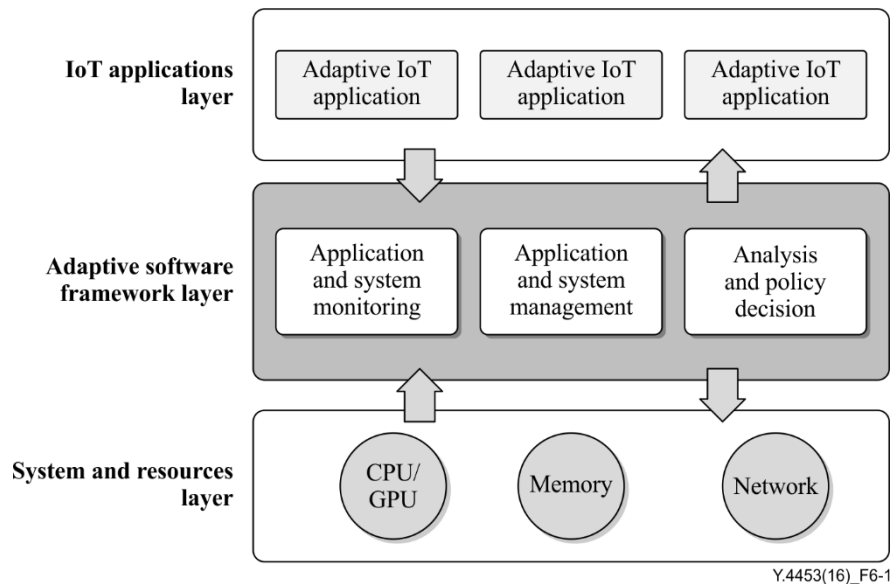


Figure 6-1 – A conceptual diagram of the ASF

The ASF gets more meaningful values under the current IoT service, because it enables resource-limited IoT devices to achieve high performance and compatibility over typical IoT systems. The ASF allows for the development of resource-managed IoT applications without a user's control. Also, the ASF provides functionalities to monitor and control application/system resources for IoT service interoperability. These functionalities make it easy to extend existing IoT systems.

The ASF enables developers to achieve high-performance, low power for applications. In addition, it can not only reduce typical software development complexity, but can also resolve the emerging complexities in diverse IoT applications and devices.

7 ASF features and high-level requirements

This clause describes the ASF features in accordance with the IoT reference model illustrated in Figure 7-1, as given by [ITU-T Y.4000] and high-level requirements of the ASF.