

Recommendation

ITU-T Y.4493 (11/2023)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

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

Autonomic operations support protocols in the Internet of things

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Recommendation ITU-T Y.4493

Autonomic operations support protocols in the Internet of things

Summary

Recommendation ITU-T Y.4493 describes autonomic operations support protocols in the Internet of things (IoT) based on the architecture of the IoT specified in Recommendation ITU-T Y.4416, in order to support provisioning of autonomic operation capabilities specified in Recommendation ITU-T Y.4401. Recommendation ITU-T Y.4493 describes the architecture of autonomic operations support protocols in the IoT for: autonomic event management; autonomic control; and autonomic policy management. Possible deployment and relevant use cases of these autonomic operations support protocols in the IoT are described.

History *

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Autonomic operation, event management, Internet of things, policy management, protocols.

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Recommendation ITU-T Y.4493

Autonomic operations support protocols in the Internet of things

1 Scope

This Recommendation describes architecture for autonomic operations support protocols, such as autonomic service provisioning and autonomic data operation specified in [ITU-T Y.4401], in the Internet of things (IoT) based on the architecture of the IoT specified in [ITU-T Y.4416]. This Recommendation specifies protocols to support autonomic event management, autonomic control and autonomic policy management based on IoT functional entities (FEs) and referenced points extended in [ITU-T Y.4416] in order to support autonomic operations in the IoT.

This Recommendation includes:

- architecture of autonomic operations support protocols in the IoT;
- autonomic event management support protocol (AEM-SP) in the IoT;
- autonomic control support protocol (AC-SP) in the IoT.
- autonomic policy management support protocol (APM-SP) in the IoT.

The security of autonomic operations support protocols in the IoT specified in this Recommendation is considered, and possible deployment and relevant use cases are described.

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.4401] Recommendation ITU-T Y.4401/Y.2068 (2015), *Functional framework and capabilities of the Internet of things*.
- [ITU-T Y.4416] Recommendation ITU-T Y.4416 (2018), *Architecture of the Internet of things based on next generation network evolution*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 Internet of things [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 broad perspective, the IoT can be perceived as a vision with technological and societal implications.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Autonomic Control
AEM	Autonomic Event Management
APM	Autonomic Policy Management
DEM	Data Event Management
DSA	Data Service Adaptation
EAC	End-point Access Control
EEM	End-point Event Management
FE	Functional Entity
ID	Identifier
IoT	Internet of Things
NGN	Next Generation Network
NGNe	Next Generation Network evolution
SP	Support Protocol
SPA	Service Provision Adaptation
TCA	Transport Configuration Adaptation
TEM	Transport Event Management

5 Conventions

None.

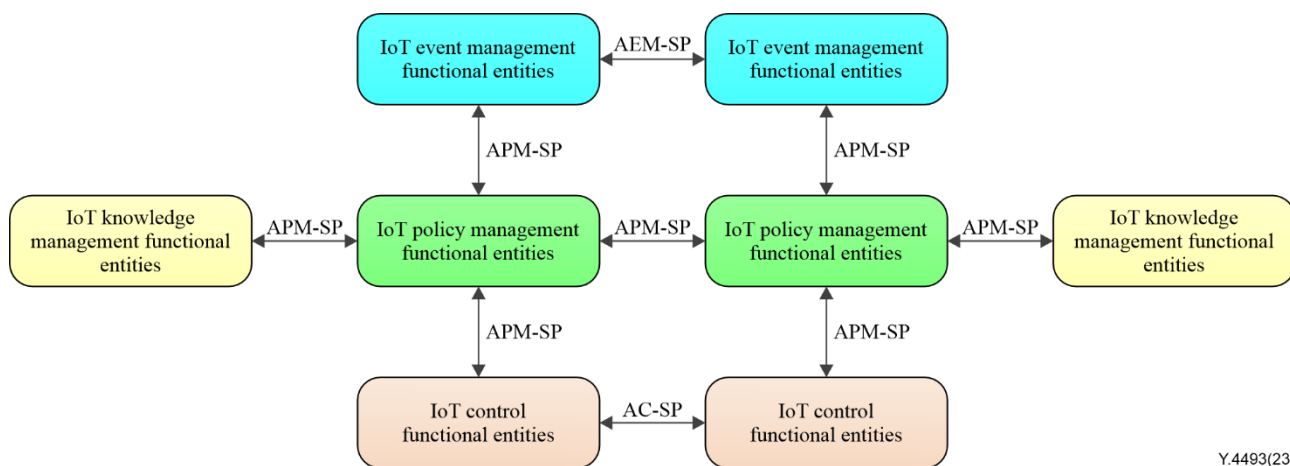
6 Architecture of autonomic operations support protocols

6.1 Overview of the architecture of autonomic operations support protocols

The architecture of autonomic operations support protocols includes the FEs of the IoT architecture specified in [ITU-T Y.4416], the relations of these FEs by using the protocols of supporting autonomic operations in the IoT, and the functions of these protocols in supporting autonomic operations in the IoT.

In this Recommendation, autonomic operations refer to activities related to the set of autonomic capabilities specified in [ITU-T Y.4401], such as autonomic service provisioning, autonomic networking and autonomic data operation.

The architecture of autonomic operations support protocols is illustrated in Figure 6-1. They can be classified as: AEM-SP; AC-SP; or APM-SP.



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Figure 6-1 – Architecture of autonomic operations support protocols

The AEM-SP is used to implement the reference points among IoT event management FEs. The IoT event management FEs specified in [ITU-T Y.4416] are listed in clause 6.2. The reference points among IoT event management FEs, which include TI-EI-1, DI-EI-1, DI-TI-1, SI-EI-1, SI-TI-1 and SI-DI-1, are also specified in [ITU-T Y.4416].

The AC-SP is used to implement the reference points among IoT control FEs. The IoT control FEs specified in [ITU-T Y.4416] are listed in clause 6.3. The reference points among IoT control FEs, which include TI-EI-2, DI-EI-2, DI-TI-2, SI-EI-2, SI-TI-2 and SI-DI-2, are also specified in [ITU-T Y.4416].

The APM-SP is used to implement three types of reference point. The first type is between IoT event management FEs and IoT policy management FEs. The IoT policy management FEs specified in [ITU-T Y.4416] are listed in clause 6.4. These reference points between IoT event management FEs and IoT policy management FEs, which include EI-EI-1, TI-TI-1, DI-DI-1 and SI-SI-1, are also specified in [ITU-T Y.4416].

The second type of reference point implemented by the APM-SP is between IoT control FEs and IoT policy management FEs. These reference points between IoT control FEs and IoT policy management FEs, which include EI-EI-2, TI-TI-2, DI-DI-2 and SI-SI-2, are specified in [ITU-T Y.4416].

The third type of reference point implemented by the APM-SP is between IoT knowledge management FEs and IoT policy management FEs. The IoT knowledge management FEs specified in [ITU-T Y.4416] are listed in clause 6.4. These reference points between IoT knowledge management FEs and IoT policy management FEs, which include EI-EI-3, TI-TI-3, DI-DI-3 and SI-SI-3, are also specified in [ITU-T Y.4416].

The APM-SP can also be used among distributed implementations of the same type of IoT policy management FEs as illustrated in Figure 6-1, in order to collaborate with IoT policy management in the same functional layer.

NOTE – These three autonomic operations support protocols only implement those reference points that are among or between IoT FEs extended to support IoT capabilities in [ITU-T Y.4416]. These three protocols do not implement all reference point related to the FEs of next generation network (NGN) evolution that are enhanced to support IoT capabilities in [ITU-T Y.4416]. So, specifications of all protocols based on NGN evolution lie outside the scope of this Recommendation.

6.2 Functions of autonomic event management support protocol

The AEM-SP can be used to implement reference points among IoT event management FEs, which include the IoT end-point event management FE (IoT-EEM-FE), IoT transport event management FE (IoT-TEM-FE), IoT data event management FE (IoT-DEM-FE) and IoT service event management

FE (IoT-SEM-FE). All these IoT event management-related FEFs and their related reference points are specified in [ITU-T Y.4416].

The functions of AEM-SP include:

- collecting events that occurred in different IoT functional layers in order to support cross-layer IoT event capturing;
- collecting events that occurred in distributed implementations of the same type of IoT event management FE in order to support distributed IoT event capturing;
- collaborating events processing with other event management FEs in different IoT functional layers in order to support cross-layer IoT event processing;
- collaborating with events processing among distributed implementations of the same type of IoT event management FEs in order to support distributed IoT event processing.

6.3 Functions of autonomic control support protocol

The AC-SP can be used to implement the reference points among IoT control FEs, which include the IoT end-point access control FE (IoT-EAC-FE), IoT transport configuration adaptation FE (IoT-TCA-FE), IoT data service adaptation FE (IoT-DSA-FE), and IoT service provision adaptation FE (IoT-SPA-FE). All these IoT control-related FEs and their related reference points are specified in [ITU-T Y.4416].

The functions of AC-SP include:

- collaborating IoT configuration and adaptation control with other IoT control FEs in different IoT functional layers in order to support cross-layer control of IoT autonomic operations and initiate possible autonomic operations across different functional layers of the IoT;
- collaborating with IoT configuration and adaptation control among distributed implementations of one type of IoT control FEs in order to support distributed control of IoT autonomic operations and initiate possible autonomic operations within the same functional layers of the IoT.

6.4 Functions of autonomic policy management support protocol

The (APM-SP can be used to implement reference points of IoT policy management FEs in the same functional layer, which include the IoT end-point policy enforcement FE (IoT-EPE-FE), IoT transport policy enforcement FE (IoT-TPE-FE), IoT data policy enforcement FE (IoT-DPE-FE) and IoT service policy enforcement FE (IoT-SPE-FE). All these IoT policy management FEs and their related reference points are specified in [ITU-T Y.4416].

The APM-SP can be used to implement reference points between IoT event management FEs and IoT policy management FEs, in order to support the functions of policy-enforced IoT event management.

The APM-SP can be used to implement reference points between IoT control FEs and IoT policy management FEs, in order to support the functions of policy-enforced IoT control.

The APM-SP can be used to implement reference points between IoT policy management FEs and IoT knowledge management FEs, in order to support the functions of controlling new knowledge learning in the IoT knowledge management FEs and updating policies based on the new knowledge.

The IoT knowledge management FEs include the IoT end-point knowledge management FE (IoT-EKM-FE), IoT transport knowledge management FE (IoT-TKM-FE), IoT data knowledge management FE (IoT-DKM-FE), and IoT service knowledge management FE (IoT-SKM-FE). All these IoT knowledge management FEs are specified in [ITU-T Y.4416].

The functions of the APM-SP include:

- controlling and obtaining new knowledge learned in the IoT knowledge management FEs in order to update intelligent policies to support IoT autonomic operations in some unknown environments, such as an IoT device moving to a new operating environment;
- collaborating with IoT policy management among distributed implementations of one type of IoT policy enforcement FEs in order to support distributed policy enforcement on the IoT autonomic operations;
- collaborating with IoT event management FEs in order to support the functions of IoT autonomic operations with the help of policy-enforced IoT event management capabilities;
- collaborating with IoT control FEs in order to support the functions of IoT autonomic operations with the help of policy-enforced IoT control capabilities.

NOTE – The cross-layer policy management should be under control of human operators. The function of cross-layer policy management lies outside the scope of this Recommendation.

7 Autonomic event management support protocol

7.1 Scope of autonomic event management support protocol

The scope of the AEM-SP includes the two following aspects:

- exchange of event management messages among IoT event management FEs of different functional layers, in order to coordinate event management of different functional layers and support event capturing and processing across different functional layers of the IoT;
- exchange of event management messages among IoT event management FEs within the same functional layers, in order to coordinate event management of the same functional layers and support event capturing and processing among the networked nodes of the IoT.

The scope of the AEM-SP is illustrated in Figure 7-1. The IoT event management FEs illustrated in Figure 7-1, such as EI-1: IoT-EEM-FE, TI-1: IoT-TEM-FE, DI-1: IoT-DEM-FE and SI-1: IoT-SEM-FE, are specified in [ITU-T Y.4416].

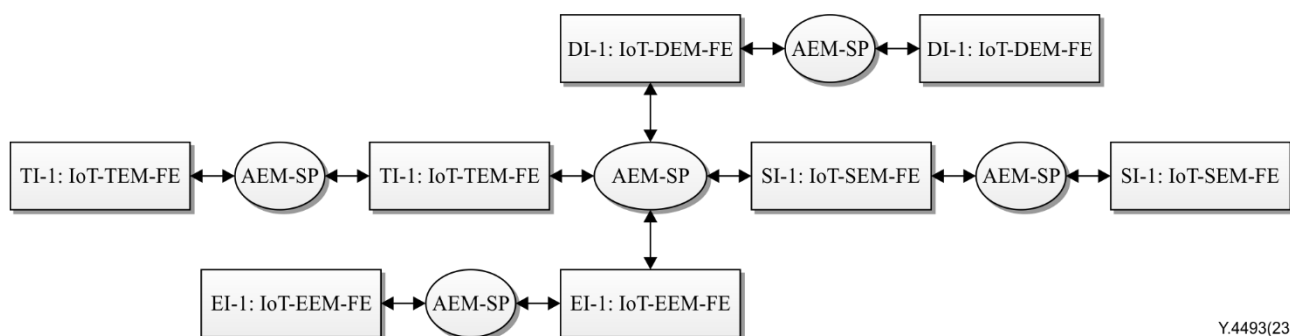


Figure 7-1 – Scope of autonomic event management support protocol

7.2 Features of autonomic event management support protocol

The AEM-SP includes the following features:

- the AEM-SP is a group protocol (as illustrated in Figure 7-1) that can send messages to several IoT event management FEs that belong to one group;
- different AEM-SP groups can be established to manage different types of events.

7.3 Message structure of autonomic event management support protocol

The message structure of the AEM-SP consists of a message head and message body. The message head consists of an AEM-SP identifier (AEM-SP-ID, 8 bits), protocol version number (8 bits), and message length (16 bits). The message body consists of several AEM-SP fields. Each field consists