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SmartM2M;
AI for IoT: A Proof of Concept

Reference

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Contents

Figures

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The present document is addressing the development of a Proof of Concept based on three Use Cases analysed and selected in the associated ETSI TR 103 674 [i.1]. ETSI TR 103 674 [i.1] addresses the issues related to the introduction of AI into IoT systems and, as first priority, into the oneM2M architecture. ETSI TR 103 674 [i.1] has identified and described several Use Cases of which three are used for the development of the Proof of Concept described in the present document.

1 Scope

The following points are discussed:

- Description of the Use Case implemented as a Proof of Concept.
- Description of the implementation: architecture, oneM2M platform used, open source support, etc.
- Main findings regarding the impact on the oneM2M architecture.
- Lessons learned, guidelines and recommendations.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long-term validity.

The following referenced documents are not necessary for the application of the present document, but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 674 (2020): "SmartM2M; Artificial Intelligence and the oneM2M architecture".

[i.2] Kaggle: "Real or Not? NLP with Disaster Tweets".

NOTE: Available at https://www.kaggle.com/c/nlp-getting-started.

[i.3] GloVe: "Global Vectors for Word Representation".

NOTE: Available at https://nlp.stanford.edu/projects/glove/.

[i.4] Readthedocs: "Gateway and backend configuration".

NOTE: Available at https://fiware-openmtc.readthedocs.io/en/latest/reference-doc/gateway-and-backend-configuration/index.html.

[i.5] GitHub: "Gateway and backend configuration".

NOTE: Available at https://github.com/OpenMTC/OpenMTC/blob/master/doc/reference-doc/gateway-and-backend-configuration.md#pluginsopenmtc-cse.

[i.6] ISO/IEC 2382-31:1997: "Information technology -- Vocabulary -- Part 31: Artificial intelligence -- Machine learning".

NOTE: This standard is withdrawn and revised by ISO/IEC 2382:2015.

[i.7] ETSI TR 103 306: "CYBER; Global Cyber Security Ecosystem".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Artificial Intelligence (AI): refers to "a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation"

Machine Learning (ML):

- Machine Learning is the process by which a functional unit improves its performance by acquiring new knowledge or skills, or by reorganizing existing knowledge or skills.

NOTE 1: Source ISO/IEC 2382-31 [i.6].

- Machine Learning is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence.

NOTE 2: Source Wikipedia.

oneM2M: Partnership Project (PP) on M2M launched by a number of SSOs including ETSI

open source license: type of license for computer software and other products that allows the source code, blueprint or design to be used, modified and/or shared under defined terms and conditions

NOTE: Examples of popular Open Source licenses are: Apache License 2.0, GNU General Public License (GPL) or Eclipse Public License.

Open Source Software (OSS): computer software that is available in source code form

NOTE: The source code and certain other rights normally reserved for copyright holders are provided under an Open Source license that permits users to study, change, improve and at times also to distribute the software.

Standards Development Organization (SDO): standards setting organization that has a formal recognition by international treaties, regulation, etc.

NOTE: In the present document, SSO is used equally for both Standards Setting Organization or Standards Developing Organizations (SDO).

Standards Setting Organization (SSO): any entity whose primary activities are developing, coordinating, promulgating, revising, amending, reissuing, interpreting or otherwise maintaining standards that address the interests of a wide base of users outside the standards development organization

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TR 103 306 [i.7] and the following apply:

AI	Artificial Intelligence
API	Application Programming Interface
ARIMA	Autoregressive Integrated Moving Average
IoT	Internet of Things
ML	Machine Learning
OSS	Open Source Software
PoC	Proof of Concept

SDO	Standard Development Organization
SSO	Standards Setting Organization
UC	Use Case

4 AI and oneM2M: A Proof of Concept

4.1 The Proof of Concept Use Cases

The emergence of Artificial Intelligence (AI) and Machine Learning (ML) solutions applicable within IoT systems is an opportunity to introduce new functionalities as well as a potential challenge to the existing solutions.

The Proof of Concept (PoC) described in the present document is based on the collection and analysis of relevant use cases done in the associated ETSI TR 103 674 [i.1]. ETSI TR 103 674 [i.1] has made a detailed analysis of the potential impact of AI/ML on the IoT systems architectures and solutions, identified and described several Use Cases of which three are used for the development of the Proof of Concept described in the present document and identified the main validation objectives for the Proof of Concept described in the present document.

4.2 An implementation and the lessons learned

The present document is focused on the presentation of the PoC implementation: a description of the selected UC, the presentation of the technical solutions chosen for the implementation of the UC, and a discussion of the main impacts identified during the implementation.

4.3 Purpose and content of the present document

The present document addresses the implementation of a Proof of Concept (PoC) designed for an evaluation of the potential impact (in particular in terms of improvement) that Artificial Intelligence can bring to IoT systems, more specifically its impact on existing solutions such as the service layer architecture developed by the oneM2M Partnership Project. This PoC is based on the implementation of three Use Cases that has been also described in the associated ETSI TR 103 674 [i.1]. This PoC is using different implementations of a oneM2M platform with the addition of solutions coming, for the most part, from the Open Source Software community.

The target group for the present document is the community of people that is interested in the understanding of the challenges and the potential solutions of the introduction of AI in a concrete implementation of an IoT system.

Clause 5 presents the use cases selected and implemented for the Proof of Concept.

Clause 6 discusses the main elements of each the Use Cases: architecture, resources and attributes, message flow and main implementation characteristics.

Clause 7 presents some lessons learned from the above analysis.

5 Use Cases implemented for the Proof of Concept

5.0 Foreword

This clause is presenting the three Use Cases (UCs) selected for the Proof of Concept. After several Use Cases have been analysed in the associated ETSI TR 103 674 [i.1], three of them have been selected for the Proof of Concept. The rationale behind the selection of these Use Cases is to make sure that they can address a large span of situations, thus ensuring that they touch the largest possible set of issues.

Consequently, the PoC will be comprising three use cases:

- Use Case 1 on Fault detection will address more specifically measurements.

- Use Case 2 on Visual recognition will address more specifically images.
- Use Case 3 on occurrences classification will address more specifically textual content.

The PoC Use Cases have been implemented on two different oneM2M platforms and are available on the ETSI forge (https://labs.etsi.org/rep/iot/smartm2m-ai-for-iot-poc).

5.1 PoC UC1: Fault management and isolation for IoT field devices

Fault detection aims to identify defective states and conditions within computing systems, subsystems and components and ensure their proper functionality to reduce their rate of deterioration, hence better customer experience. There is a need to be an effective maintenance service in place to ensure that IoT devices are running at their best. The inputs of maintenance services are measurements reflecting the health state of the monitored item.

In this use case, an IoT module will be prototyped for fault detection and isolation of IoT device data in a smart building environment using both a rule-based fault detection and a self-learning fault detection algorithm based on e.g. statistics sliding window approach. The rule-based approach would be based on available manufacturer datasheets including rules if available. The self-learning algorithm is based on determining trend vectors and comparing such vectors with longer term historic data.

5.2 PoC UC2: Detection of patterns in video streams

Detection of patterns in video and camera streams enables users to identify scenes, objects, and situations in images uploaded to the service using aims visual recognition based on Artificial Intelligence and Machine learning. Subjects and objects contained in an image are automatically identified, organized and classified into logical categories in order to provide add high added value services in cities such as car vandalism and fire detection.

In this use case, an IoT module will be prototyped for images classification using machine learning and trained data. The IoT module supports multiple classifiers: predefined and custom models. A camera agent will be developed to quickly test the proposed prototype and simplify the integration with real devices within the city. The camera agent reads periodically images from the disk and push them to oneM2M platform. The images could be provided by a real camera or any other external sources.

5.3 PoC UC3: Language-based pattern recognition in social media/crowdsourced data for occurrences classification

In the Smart Cities environment, data comes in many formats from different sources. The common presented use case tends to be through sensors, but data obtained directly from citizens, through what they publish on social networks or share through other means (e.g. mobile apps to report incidents) can be very insightful and valuable. However, this crowd-sourced data is not structured, and its quality can be questionable (i.e. containing typos, incorrect grammar and incomplete location). As such, special care has to be taken in order to obtain insights from it since it can be a useful source of information about what is happening throughout the city in a relatively seamless way.

Within this use case, a prototype of a Common Service Function will be developed, which will provide the functionality of cleaning text data to be used in ML methods. With this functionality, and with the support of the OpenMTC implementation of oneM2M, a system will be developed to fetch data from Tweets or other sources, which can potentially be describing a disaster somewhere, automatically clean the data using the developed CSF, and feed this data into a neural network that classifies the provided text in regards if it is reporting a disaster or not.

6 Details of the Proof of Concept Implementation

6.1 PoC UC1: Fault management and isolation for IoT field devices

6.1.1 Architecture

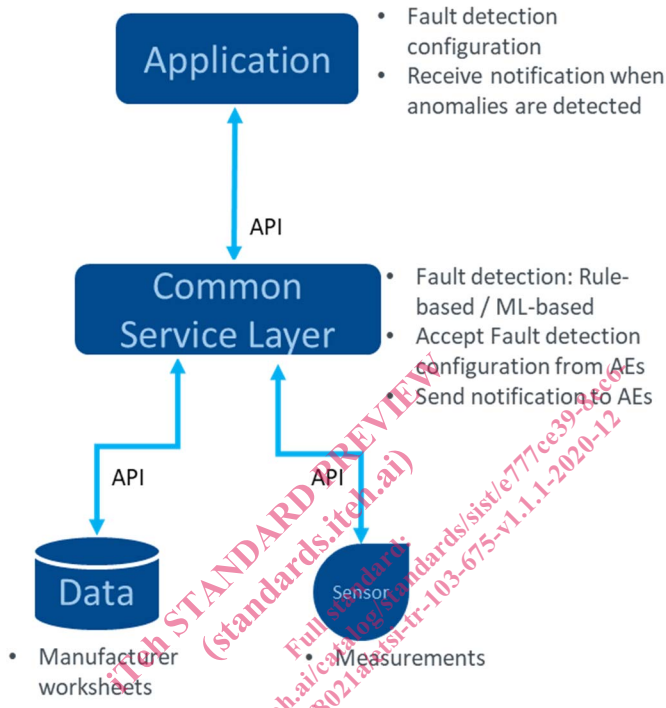

Figure 1: High-Level Architecture of Use Case 1

6.1.2 Resources and attributes

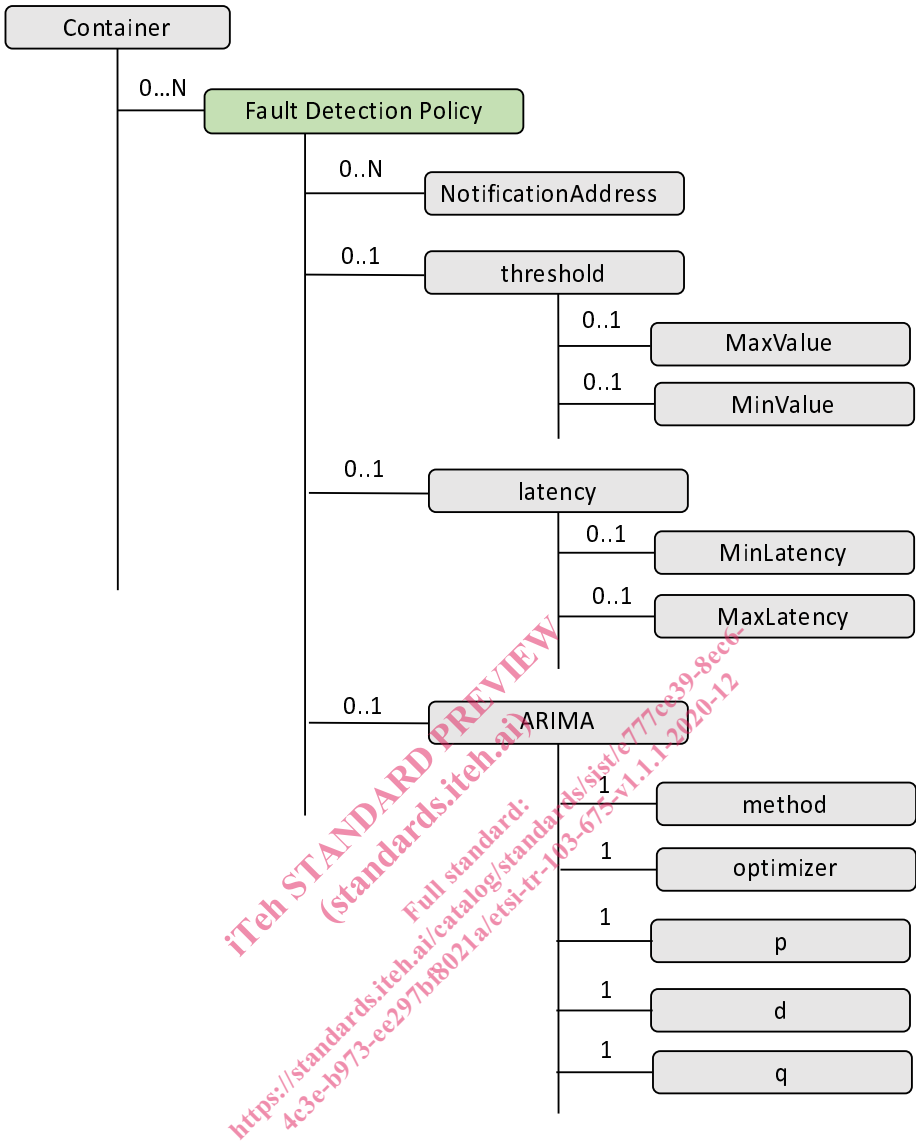

Figure 2: Fault detection policy

6.1.3 Message flow

Figure 3 depicts the entities and main components involved in the use case and the sequence of messages exchanged between them to carry out the functionality needed for fault management and isolation for IoT field devices in oneM2M platform. The blue boxes show the interactions that are achievable with oneM2M platform without any changes, while the green boxes show new interactions that do not currently exist in oneM2M and need to be specified and implemented for this use case.