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Fighting pandemic disease with Internet of Things (IoT)

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Foreword

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

Modal verbs terminology

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Executive summary

The present document defines properties and usage of IoT and M2M technology in Contact Tracing.

It introduces the method of Asynchronous Contact Tracing (ACT). ACT registers the presence of SARS-CoV-2 virus on IoT connected objects (waste water, or air conditioning filters, or dirty objects, or dirty cleaning tools, etc.) or connected locations (such as a shops, restaurants, corridors in a supermarket, sanitary facilities in a shopping mall, railway stations, airports terminals and gates, etc.) using Group Test (sometime called in the literature Pooling Test).

ACT identifies contacts with IoT connected objects that have been contaminated by the SARS-CoV-2 virus and works in synergy with solutions designed for manual and digital contact tracing to identify and alert people who may have been infected by the virus. In case the object is suspected to host or have hosted the SARS-CoV-2 virus, ACT allows users that have been in contact with the object or visited the connected location to be informed.

This shifts the paradigm from synchronously tracing the contacts of the people infected by COVID-19 to asynchronously tracing of contacts of materials (such as infected surfaces, waste-water, air-conditioning filters, etc.) that are hosting the SARS-CoV-2 virus.

This enables people who have come into contact asynchronously with those particular materials to be alerted of a potential COVID-19 contagion, and, at the same time, it signals that one or more persons have been in contact with the material which is now spreading the SARS-CoV-2 virus.

This methodology is particularly effective as the SARS-CoV-2 virus can survive for a significant time on objects that have been contaminated. The degree of contamination depends on the object (e.g. a surface), the concentration of the virus, the temperature, the humidity conditions, and the exposure to sun light. Viral contamination can be active for a few hours or last for several days.

The ACT method uses existing, ready-to-market IoT-based technology and well-established wireless network techniques. The methodology is not dependent on achieving a certain number of tests, or of people adopting it, in order for the results to be useful, but from the number of (grouping) tests performed. Moreover, it does not require the transmission of any personal information by the user, respecting both EU GDPR (General Data Protection Regulation) and people's sensibility to personal privacy.

The present document also shows a number of relevant case studies in many different areas.

The present document also defined requirements and the functionalities required to meet the requirements.

The present document specifies a solution for the ACT method using the oneM2M standard communication framework.

This process was inspired by Occam's Razor [i.5] or the *Law of Parsimony* (Latin: *Lex Parsimoniae*), that states that entities and theories useful to solve a problem should not be multiplied unless necessary. On the contrary, simpler entities and theories are preferable to more complex ones because they are easier to test and more likely to be true.

Introduction

"*C'est un projet qui répond à une crise historique sans laquelle il n'existerait pas et au-delà de laquelle il n'existera pas: l'épidémie de COVID-19*" [i.10].

Asynchronous Contact Tracing is a method (network protocol + appropriate IoT infrastructure based on SmartM2M/oneM2M + mobile and web applications) [i.15] conceived for regular, 'peace time' use, as opposed to (Synchronous) Contact Tracing methods [i.6], [i.7], [i.8] and [i.9] which tend to be employed when society is put on an urgent, war footing in reaction to an acute problem.

The ACT process is not only applicable to the current pandemic wave. The parameters can be adapted to any other virus in a future pandemic.

ACT is able to work alone or in coordination with all existing (Synchronous) Contact Tracing solutions. It has been designed as a service and a methodology that will be available for all pandemic, epidemic and other contagious illnesses, as well as for other applications intended for protecting and tracing users. ACT is not only applicable to the current wave of COVID-19. The parameters can be adapted to any other virus as required, and for testing and tracing of e.g. situations related to leaks of discomforting or dangerous gasses and liquids.

ACT is intended to be socially and economically acceptable to people who consider Asynchronous Contact Tracing to be a social-service (that is offered by, for example, a health or social security organization) and should not be perceived to be an obligatory requirement.

ACT will promote individual testing only in the unfortunate event of the user receiving official notifications that he/she may be potentially at risk. It can be applied to all the contexts where people share the same physical space, such as a supermarket, schools, restaurants, hotels, gyms, offices, working plants, hospitals, hospices, etc. It can also be applied to an object that is encountering people while it is in movement, such as a public transportation network.

ACT traces the contacts of objects with people and other objects and uses IoT technologies to react when a connected object may 'host' or 'has hosted' the virus and spread the virus to other people. It is intrinsically asynchronous because it does not require people to be in the same place at the same time, and, even stronger, it does not require the exchange of any information between people, as the virus will be tracked back, or uncovered by doing (group) testing on objects and not on people.

For many communities, this type of tracing will promote a quicker return to normal after, or avoiding lockdowns. This will benefit many social and industrial organizations, cities, tourism, education, commerce, and travel, etc.

ACT has been designed as a service and a methodology that will also be available for COVID-19 and future pandemic attacks.

ACT traces the contacts of objects with people and other objects and uses IoT technologies to react in the case that such connected object will 'host' the virus and widespread a pandemic virus with people.

The process is intrinsically asynchronous because it does not require people to be in the same place and at the same time, and, more importantly, it does not require any information exchange between humans, since the virus has been detected by Group Testing on materials and not on humans.

For many communities, this type of tracing will support an elaborate form of selective lockdown, i.e. the surgical closure of specific areas following a forecast announcing a new spike of infection. It is without doubt a process that will naturally benefit many social and industrial organizations, cities, tourism, education, commerce, and travel, etc.

1 Scope

The present document is structured as follows:

- Clauses 1 to 3 set the scene and provide references as well as definitions of terms, symbols and abbreviations, which are used in the present document.
- Clause 4 shortly describes contact tracing and testing techniques, with in particular Dorfman's Group testing [i.1], which contributes to of the ACT methodology.
- Clause 5 describes some use cases that are be useful to understand the usefulness of ACT method. These use cases provide some relevant examples (among all the potential ones in the areas of Tourism, Commerce, Transportations, Schools, Hospices, etc.) that are then used as reference for the specification development.
- Clause 6 specifies the solution for the ACT method using the oneM2M standard communication framework. It allocates the functionalities in the architectural framework of the solution and the related interfaces. It defines the oneM2M resources required to implement the functionalities. It specifies the ACT method in oneM2M, in terms of features, resources, parameters, API, considering modifications to the existing ones and/or definition of new ones.
- Clause 7 presents the ACT oneM2M communication framework.
- Annex A (normative) presents the ACT Messages Specification.
- Annex B (normative) presents some JSON messages examples.
- Annex C (informative) contains a Bibliography.
- Annex D (informative) contains the repsent document Change History.

2 References

2.1 Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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 necessary for the application of the present document.

[1] ETSI TS 118 101: "oneM2M; Functional Architecture (oneM2M TS-0001)".

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[2] IEEE 802.11-2020™: "IEEE Standard for Information technology -- Telecommunications and information exchange between Systems Local and Metropolitan Area Networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications".

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[3] ISO 8601: "Data and Time Format".

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[4] ISO 6709: "Standard representation of geographic point location by coordinates".

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[5] ETSI TS 118 111: "oneM2M; Common Terminology (oneM2M TS-0011)".

[6] ETSI TS 118 102: "oneM2M; Requirements (oneM2M TS-0002)".

[7] ETSI TS 118 104: "oneM2M; Service Layer Core Protocol Specification (oneM2M TS-0004)".

[8] ETSI TS 118 103: "oneM2M; Security solutions (oneM2M TS-0003)".

[9] ETSI TS 118 105: "oneM2M; Management Enablement (OMA) (oneM2M TS-0005).

[10] ETSI TS 118 106: "oneM2M; Management Enablement (BBF) (oneM2M TS-0006)".

[11] ETSI TS 118 109: "oneM2M; HTTP Protocol Binding (oneM2M TS-0009)".

[12] ETSI TS 118 120: "oneM2M; WebSocket Protocol Binding (oneM2M TS-0020)".

[13] ETSI TS 118 112: "oneM2M; Base Ontology (oneM2M TS-0012)".

[14] ETSI TS 118 115: "oneM2M; Testing Framework (oneM2M TS-0015)".

[15] ETSI TS 118 113: "oneM2M; Interoperability Testing (oneM2M TS-0013)".

[16] ETSI TS 118 122: "oneM2M; Field Device Configuration (oneM2M TS-0022)".

[17] oneM2M TS-0016: "Secure Environment Abstraction".

[18] ETSI TS 118 132: "MAF and MEF Interface Specification (oneM2M TS-0032)".

[19] ETSI TS 118 126: "3GPP Interworking (oneM2M TS-0026)".

[20] oneM2M TS-0030: "Ontology based Interworking".

[21] oneM2M TS-0031: "Feature Catalog".

[22] oneM2M TS-0033: "Interworking Framework".

[23] oneM2M TS-0034: "Semantics Support".

[24] ETSI TS 103 264: "SmartM2M; Smart Applications; Reference Ontology and oneM2M Mapping".

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] R. Dorfman "The detection of defective members of large populations", Annals of Mathematical Statistics, 14, 436-440, 1943.

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[i.2] Chin Awh, et al.: "Stability of SARS-CoV-2 in different environmental conditions", The Lancet Microbe 2020.

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[i.3] Van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al.: "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1", New England Journal of Medicine, 2020.

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[i.8] MIT etal. PACT (Private Automated Contact Tracing).

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[i.9] Apple and Google: Privacy-Preserving Contact Tracing.

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[i.17] ETSI TR 118 525: "oneM2M; Application Developer Guide".

[i.18] ETSI TR 118 535: "oneM2M; Developer guide: device management (oneM2M TR-0035)".

[i.19] ETSI TR 118 545: " oneM2M; Developer Guide: Implementing Semantics (oneM2M TR-0045)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

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

5G	Fifth generation technology standard for broadband cellular networks
ACT	Asynchronous Contact Tracing
AE	Application Entity (in oneM2M architecture)
AI	Artificial Intelligence
API	Application Programming Interface
ASN	Application Service Node
ATM	Automated Teller Machine

NOTE: In French: DAB Distributeur Automatique de Billets.

BSSID	Basic Service Set IDentifier
COVID-19	Coronavirus Disease 2019
CSE	Common Service Entity
CT	Contact Tracing
EU	European Union
GUI	Graphical User Interface
ICT	Information and Communication Technology
IPE	Interworking Proxy Entity
JSON	Java Script Object Notation
MAC	Media Access Control (physical address)
oneM2M	ETSI standards for M2M and the Internet of Things
PC	Personal Computer
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SCT	Synchronous Contact Tracing
SSID	Service Set Identifier
UX/UI	User Experience/User Interface
WiFi	IEEE 802.11 family of standards

NOTE: Based on the IEEE 802.11 [2] family of standards

WLAN	Wireless Local Area Network

4 Testing and Contact Tracing

4.1 Introduction

Lockdown

The main weapon against COVID-19 currently available is physical distancing and it requires full/partial/selective lockdown of cluster areas in the event of a high peak in the spread of the virus. This creates severe damage to an economy and to the personal life of its citizens. While people are all waiting for a vaccine, the other relevant tool to fight the virus is testing. Unfortunately, widespread testing of large populations in a very short time remains unpracticable. The single testing would require some million tests per week and about 60 weeks for a nation such as France. This is clearly an unworkable solution to the problems raised by the current pandemic and is common to many countries across the world.

It is also clear that many people are unwilling to be COVID-19 tested for social reasons, such as job restriction, economic consequences, violation of private life, or even fear of quarantine. It is now well understood that without widespread testing of the population, the only weapon against COVID-19 is lockdown and subsequent severe economic and social disruption.

Contact Tracing

Contact Tracing (CT) has been actively used in Europe since the 16th century to contain epidemic disease. The principles remain the same today whether carried out by phone, mail or personal contact. The aim is to identify the origin of the infection and to where, or to whom, it has been transferred. If receipt of this information is followed immediately by isolation, treatment and aggressive decontamination, it can lead to containment and the gradual elimination of the disease itself.

The year 2020 has seen an explosive demand for information about COVID-19. It rapidly focused on the possible use of new technology, and particularly on the capabilities of the mobile phone to automate the process of 'track and trace', producing more accurate and timely information flows - to the advantage of public health, governments and the patient and their personal contacts. The potential of 5G and AI seemed to beckon to a future where silent, rapid transmission of data would protect us all from an unseen virus that observes no political or social boundaries.

There was an immediate counter reaction - this degree of protection might also be intrusive. It threatened the security of our private lives, our right to move freely and our right to confidentiality, particularly in the medical field. There have been many public statements asserting that current practice of CT observes Human Rights as expressed by the EU, but the resulting focus on the individual subject of CT has led to much confusion as to the purpose and direction of the resulting data collection.

Who Needs to Know? And What do they Need to Know?

These are questions that initially were considered to have obvious answers. Design of ICT systems for CT would follow the traditional, manual methodology but should make it faster, more accurate, more useful. Solutions were found to protect the individuals' personal rights and freedoms, but little attention was paid to the 'back-end' - the ultimate destination of the data and the use to which it would be put.

Put simply, it has always been true that security and transparency share a trade-off. One threatens the other. If the potential patient, the user of the 'track and trace' enabled phone is to be fully protected then the program should not store their name or contact details in any way that could lead to their identification.

This debate has distracted attention from an important issue. Track and trace exercises in the past have been used principally to support government and public health initiatives not just to inform the individual as to their potential risk. Common modern focus on the rights of the individual threatens the management of track and trace data, which could seriously minimize its usefulness to central authorities which all people hold responsible for containing the infection.

Testing for the SARS-CoV-2 virus

Testing is essential to the fight against the SARS-CoV-2 virus and it should be accurate. At the present moment, there are different products based on two methodologies, namely virologic tests (e.g. RT-PCR) and antibodies tests. Unfortunately, the accuracy of the tests is not absolute, and this lead to test repetitions and especially to interpret inconsistent results, e.g. VIRAL=POSITIVE and ANTIBODY=NEGATIVE.