

ETSI Technical Specification TS 103757. SmartM2M; Asynchronous Contact Tracing System

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Contents

Intellectual Property Rights 5
Foreword 5
Modal verbs terminology 5
Executive summary 5
Introduction 6
1 Scope 8
2 References 8
2.1 Normative references 8
2.2 Informative references 9
3 Definition of terms, symbols and abbreviations 11
3.1 Terms 11
3.2 Symbols 11
3.3 Abbreviations 11
4 Testing and Contact Tracing 12
4.1 Introduction 12
4.2 Tracing and testing problems encountered during this COVID-19 pandemic 13
4.3 Dorfman's group testing methodology 13
4.4 ACT overview 14
5 ACT Method Architecture and Solutions 15
5.1 ACT Method Architecture and Functionalities 15
5.2 ACT messages 18
5.2.1 Service Identifiers 18
5.2.2 Information broadcasted by ACT Peripheral Service (and listened by ACT Smart Mobile Application) 18
5.2.3 Information exchanged between ACT Detection Service and ACT Local Service 19
5.2.4 Information exchanged between ACT Local Service and ACT Peripheral Service 20
5.2.5 Information exchanged between ACT Local Service and ACT Control Service 20
5.2.6 Information exchanged between ACT Smart Mobile Application and ACT Control Service 21
5.2.7 Information exchanged between ACT Display Application and ACT Control Service 23
5.2.8 Information exchanged between different ACT Control Services 24
5.3 oneM2M Resources to implement the ACT Services 25
5.4 Security, Privacy and Cybersecurity support 27
5.5 Management support 27
6 Asynchronous Contact Tracing oneM2M Communication Framework 27
6.1 Introduction 27
6.2 Asynchronous Contact Tracing Communication Framework 28
Annex A (normative): ACT Messages Specification 29
A.1 Information exchanged between Detection Service and Local Service 29
A.2 Information exchanged between Local Service and Peripheral Service 29
A.3 Information exchanged between Local Service and National Control Service 30
A.4 Information exchanged between Smart Mobile Application and National Control Service 30
A.5 Information exchanged between Display Application and National Control Service 32
A.6 Information exchanged between different National Control Services 34
Annex B (informative): JSON messages examples 36
B.1 Information exchanged between Detection Service and Local Service 36

B.2 Information exchanged between Local Service and Peripheral Service 36
B.3 Information exchanged between Local Service and National Control Service 36
B.4 Information exchanged between Smart Mobile Application and National Control Service 36
B.5 Information exchanged between Display Application and National Control Service 37
B.6 Information exchanged between different National Control Services 37
Annex C (informative): Bibliography 38
Annex D (informative): Change History 39
History 40

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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

In the present document "**shall**", "**shall not**", "**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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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 of 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) [i.20] and people's sensibility to personal privacy.

The present document defines 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 but also 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 supermarkets, 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 other 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 the ACT methodology.
- Clause 5 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 6 presents the ACT oneM2M communication framework.
- Annex A (normative) presents the ACT Messages Specification.
- Annex B (informative) presents some JSON messages.
- Annex C (informative) contains a bibliography.
- Annex D (informative) contains the present 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)".

NOTE: Available at https://www.etsi.org/deliver/etsi_ts/118100_118199/118101/.

[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".

NOTE: Available at https://standards.ieee.org/standard/802_11-2020.html.

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

NOTE: Available at https://www.iso.org/iso-8601-date-and-time-format.html.

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

NOTE: Available at https://www.iso.org/standard/39242.html.

[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".

[25] ETSI GS E4P 007: "Europe for Privacy-Preserving Pandemic Protection (E4P); Pandemic proximity tracing systems: Interoperability Framework".

[26] Geohash Geocode System.

NOTE: Available at http://geohash.org/.

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

NOTE: Available at https://projecteuclid.org/euclid.aoms/1177731363.

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

NOTE: Available at https://doi.org/10.1016/S2666-5247(20)30003-3.

[i.3] Van Doremalen N., Bushmaker T., Morris D.H., Holbrook M.G., Gamble A., Williamson B.N., 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.4] Kampf G., Todt D., Pfaender S., Steinmann E.: "Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents", Journal of Hospital Infection, 2020.

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[i.5] Schaffer J.: "What Not to Multiply Without Necessity". Australasian Journal of Philosophy. 93 (4): 644-664, 2015.

[i.6] Inria and Fraunhofer AISEC. ROBERT protocol, v1.1: ROBERT: ROBust and privacy-presERving proximity Tracing. Candidate proposal for PEPP-PT (Pan European Privacy-Preserving Proximity Tracing), 2020.

NOTE: Available at https://github.com/ROBERT-proximity-tracing/documents/blob/master/ROBERT-specification-EN-v1_1.pdf.

[i.7] EPFL et al. DP3T (Decentralized Privacy-Preserving Proximity Tracing).

NOTE: Available at https://github.com/DP-3T/documents/blob/master/DP3T%20White%20Paper.pdf.

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

NOTE: Available at https://pact.mit.edu/.

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

[i.10] Cédric O, Discours prononcé à l'Assemblé nationale, 27 Mai 2020, Assemblée Nationale, Paris, France.

NOTE: Available at https://www.vie-publique.fr/discours/275301-cedric-o-27052020-stopcovid.

[i.11] Ministère des Solidarités et de la Santé, France: "Guidez votre choix parmi les 476 fiches de tests Covid-19 du marché".

NOTE: Available at https://covid-19.sante.gouv.fr/tests. 476 is the number displayed at 11/08/2021.

[i.12] Void.

[i.13] Sizun J., Yu M.W., Talbot P.J.: "Survival of human coronaviruses 229E and OC43 in suspension and after drying on surfaces: a possible source of hospital-acquired infections", J. Hosp Infect, 2000.

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[i.15] Liquori L., Wood S. and Scarrone E.: "Asynchronous Contact Tracing", 2020.

NOTE: Available at https://hal.inria.fr/hal-02989404v2, 2020.

[i.16] ETSI TR 118 501: "oneM2M Use Case collection (oneM2M TR-001)".

[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)".

[i.20] GDPR: General Data Protection Regulation.

NOTE: Available at https://gdpr-info.eu/ and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02016R0679-20160504&qid=1532348683434.

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)
AE-ID	Application Entity-Identifier
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
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
HEPA	High-Efficiency Particulate Air
ICT	Information and Communication Technology
IN-CSE	Infrastructure Common Services Entity
IP	Internet Protocol
IPE	Interworking Proxy Entity
ISO	International Organization for Standardization
JSON	Java Script Object Notation
LAMP	Loop-mediated isothermal amplification
MAC	Media Access Control (physical address)
NAAT	Nucleic Acid Amplification Tests
oneM2M	ETSI standards for M2M and the Internet of Things
OTP	One Time Password
PC	Personal Computer
QR	Quick Response
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SARS-CoV-2	Severe Acute Respiratory Syndrome CoronaVirus 2
SCT	Synchronous Contact Tracing
SSID	Service Set Identifier
URL	Uniform Resource Locator
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 which is 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 economy and 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 are 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 and the forthcoming 2021 has seen an explosive demand for information about COVID-19. It rapidly focused on the possible use of new technologies, 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 and 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 and in the possibility to be easily geo-localized and identified. 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 andmore 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 tests based on two methodologies, namely "molecular/virologic/diagnostic" tests (< 1 day, e.g. RT-PCR, NAAT, LAMP) and "antibody/serological/blood" tests (< 1 day). 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.

There is a further problem caused by the number of commercial products available with varying standards of accuracy as well as the high cost of some testing kits. e.g. see [i.11].

There is a plethora of test solutions. This "abundance" is neither helpful nor economically sustainable. Some of the tests require access to specific processing equipment and/or skilled laboratory technician which may be expensive or not generally available in local hospitals or laboratories.

The last frontier is the "antigen/diagnostic" tests (< 1h) intended for the use as an aid in identifying individuals with an adaptive immune response to SARS-CoV-2 virus, indicating prior infection. Positive results are accurate but false positive may happen.

4.2 Tracing and testing problems encountered during this COVID-19 pandemic

For various reasons people are not tracing and testing enough persons and fast enough. Without wider test information public health authorities are limited in their decision-making capacity and current SCT alone cannot fill the gap.

People may be skeptical about using and installing current Contact Tracing applications for various reasons. 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. For example, front-line health workers may be reluctant to go risk going into lockdown, which will stop them working in hospitals and care homes where they know that they are needed, and possibly losing their job. They will only take this decision on very clear and verifiable advice.

The synchronicity rules (typically 15 minutes and the distance typically from 1 to 2 meters) of existing synchronous contact tracing are sometimes considered too stringent, resulting in the same limited number of proximity events as would result from manual CT, and not resulting in the recording of many more potentially contagious contacts that do actually occur.

In addition to tracing, the other relevant tool to fight the virus spreading is testing. Unfortunately, widespread testing of large populations in a very short space of time still remains impracticable. And it can be argued that massive testing is required when large number of people are getting contaminated, but equally when one wants to contain the spreading of the virus when the number of positive cases is low (but not zero), and herd immunity has by far not been reached.

It has been calculated that the repeated testing of a population every 14 days (i.e. the safe envelop corresponding to COVID-19 contamination) with some million tests per week would require about 60 weeks per test round for a nation of 60 million people, such as in France. This is clearly an unworkable solution to the problems raised by the current pandemic and has been noted in many countries across the world.

4.3 Dorfman's group testing methodology

During the 2nd World War Professor Dorfman invented a group testing method to screen for syphilis amongst American soldiers. The testing process people aim to use is inspired by the principle of Dorfman's Group Testing described in his seminal paper, "*The detection of defective members of large population*" [i.1]. The rationale of Group Testing is simple. A sample of blood is taken from, say, five people. These samples are mixed together and one test for the virus is made on the combined fluids. If this test result is negative then all five individual samples are considered to be negative, thus saving four test kits. If the result is positive, then the original five samples should be tested individually.

The testing methodology applied in the ACT process is a subset of the Dorfman Group Testing, namely, people are interested only in the presence or absence of the SARS-CoV-2 virus in order to make the ACT process work; the reason for this is trivial because people cannot identify the 'infectors' of waste-water, or air-filtering or other materials or goods: the waste-water or the air-filtering act like an hash-function, i.e. it would be computationally impossible to come back to the infectors. Note that infector here is used to denote either humans or things hosting the virus.

Use of this sub-kind of group testing (sometimes called pooling testing), in combination with modern digital IoT technology, may provide a new and effective forecast for the introduction of selective lockdown; this means that whenever people test an infected location, the ACT technique will communicate to the population a precise geographical area which can be defined immediately as safe or unsafe.

4.4 ACT overview

Asynchronous Contact Tracing (ACT) trace IoT connected objects that "host" the SARS-CoV-2 virus instead of the people that got infected by the SARS-CoV-2 virus.

Today, Synchronous Contact Tracing (SCT) protocols [i.6], [i.7], [i.8] and [i.9] track the chain of transmission of the virus by using the physical and spatial proximity, whilst preserving personal anonymity.

With respect to common SCT, ACT do not require two persons to be present at the same time and at a given distance in order to trace a risk of infection. ACT traces objects and surfaces or locations that have been contaminated by the virus.

The SARS-CoV-2 virus is known to stay contagious for some time in an aerosol, or on an object or a hard surface, depending on the nature of the surface, the virus concentration, temperature, humidity conditions, exposition to sun light. This time can vary from few hours to several days; some examples are 2 - 3 hours on paper, 4 hours on copper, 3 - 4 days on plastic and steel, 7 days on face masks, and even more in specific climate conditions [i.2], [i.3], [i.4], [i.13] and [i.14].

In addition to the formation and lifetime of aerosols, typical hard surfaces at risk include items such as a plastic drink bottle, a can of beer, a milk carton, a water tap or hand dryer in a public toilet, a park bench, a metro train's doors, seats, buttons, handrails, ATM machines etc. It includes everything around us.

ACT is a digital contact tracing protocol that works as follows:

- Many commercial WiFi ordinary access points, called in the ACT jargon ACT Peripheral Services, are installed in specific locations, such as a supermarket corridor, a public toilet, a metro station, a fitness or hotel room etc. Each peripheral transmits continuously two information:
  - its unique WiFi identifier (also known as the MAC identifier BSSID); it is worth to notice that since BSSID are uniquely flashed in each WiFi transmitters hardware, their replication by malicious attack is hard to be feasible;
  - its unique WiFi human-readable network name (also known as the WiFi identifier SSID); it is stated that this name shall be composed by the concatenation of the string "ACT-" with a string set according to the deployment needs.
- A smartphone, having installed the ACT Smart Mobile Application, using its WiFi radio, listens and registers in its local and protected memory, all the BSSIDs having as SSID network name prefix the "ACT-" prefix string. The ACT Smart Mobile Application can ask the ACT Control Service, directly connected with the Public Health Authority, to be informed on the forecast of the presence of COVID-19 in the geographical places visited by the smartphone owner. The geographical locations visited by the owner of the smartphone will never be shared outside the ACT Smart Mobile Application to comply with the GDPR [i.20].
- The accent is on the infected material and not on the (potential infected persons). This is an interesting application of Dorfman's Group Testing technique [i.1]. The possibility of testing material samples (waste-water / air-conditioning filters / hard surfaces) using standard, reliable, testing techniques and producing results in reasonable time is one of the elements at the basis of ACT. Testing material can be done locally, using ad-hoc and in-place (manual, automatic, or semi-automatic) ACT Detection Services, or outsourced, sending a sample of the material to the closest Biological Laboratory.
- The results of tests are sent to the ACT Local and ACT Control Service in association with the BSSID of the WiFi access points close by to the point of taking of the sample. This information is interpreted by the Public Health Authority into a precise virus forecast, which is geo-localized and finally widely communicated by the ACT Control Service to the ACT users using well-established Web techniques.
- ACT gives also a channel of communication between the Public Health Authority and the user to suggest the behaviour (e.g. to go fast for a RT-PCR test) in case that the ACT Smart Mobile Application identify a risk of infection.

- The ACT Smart Mobile Application match the BSSIDs retrieved from the ACT Control Service, each of one associated with a precise forecast, with the BSSIDs recorded in the smartphone local protected memory; in case of non-empty intersection, the ACT Smart Mobile Application notify immediately a potential contamination to the owner of the smartphone. At that point, he/she may decide to go to a Biological Laboratory for an individual unitary test.
- A desktop ACT Display Application, with a simple and intuitive GUI, access the forecasts available by the ACT Control Service and provides the situation in the areas according to the user interest.
- Additionally, the ACT Smart Mobile Application, in case the owner of the smartphone is tested positive to the virus, may send to the ACT Control Service the time of the test together with the list of pairs composed by the BSSIDs and the related timestamps. It is up to the ACT Control Service to use and eventually process those data. Mechanisms defined by the Public Health Authority are used to avoid false declaration (e.g. a QR-code, an OTP-code, a manual insertion by medical staff, etc.), with a natural integration with the Interoperability Framework of the Synchronous Contact Tracing protocols [25]. To conclude, ACT integrates novel test technologies with the modern digital IoT, providing a new and effective means to quick discover the spread of the virus in selected areas, enabling the possibility to the user to discover their exposure to the risk of infection and to the public authorities to identify circumscribed area of risk that may lead to precise and chirurgical selective lockdowns.

5 ACT Method Architecture and Solutions

5.1 ACT Method Architecture and Functionalities

The architecture and the entities required to support the ACT protocol are described in Clause 5.1 (this clause). The identified interfaces are specified in Clause 5.2. Clauses 5.3 and 5.4 specify their implementation by means of the oneM2M standard framework. The ACT architecture is depicted in Figure 5.1-1, while Figure 5.1-2 states the numerosity relation between the ACT architectural elements.

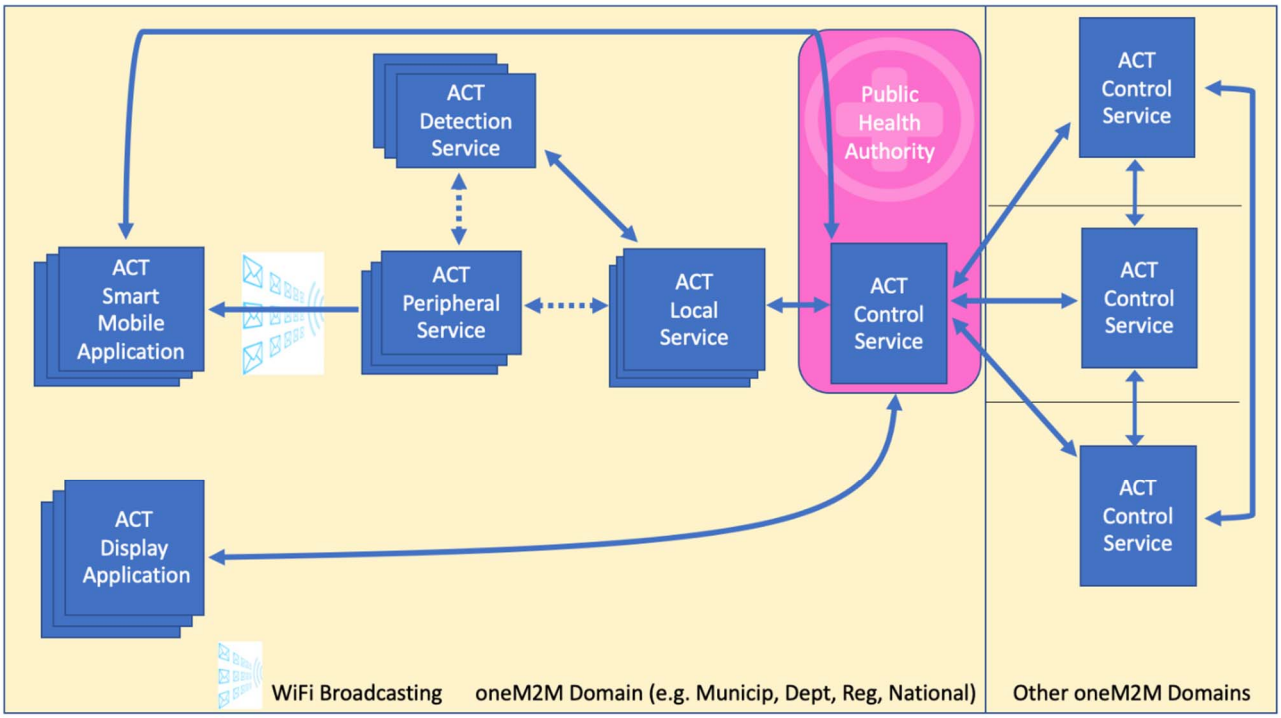


Figure 5.1-1: ACT Architecture

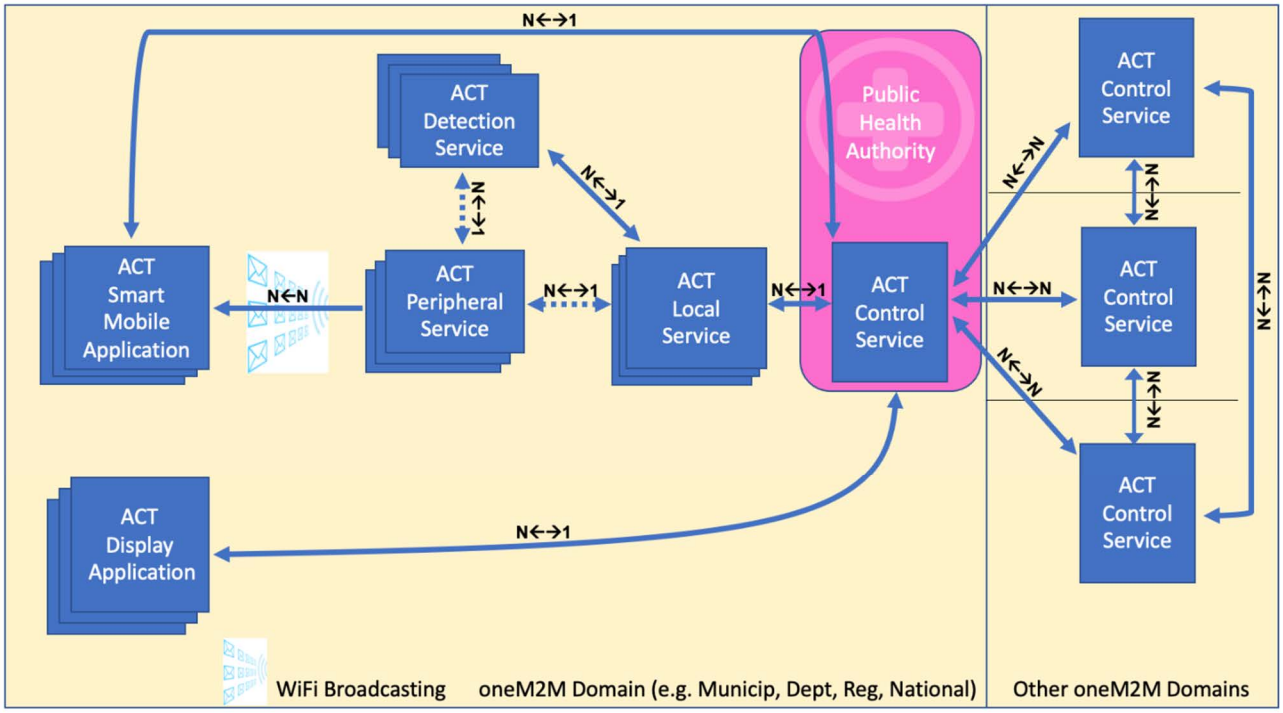


Figure 5.1-2: ACT Elements Numerosity Relations

More precisely, the relation **N←→1** means "N" instances of the ACT entities closer to the "N" in the figure, communicating with one instance of the ACT entity closer to the "1" in the figure, while **N←→N** refers to "N" instances communicating to "N" instances, and finally **N←N** means "N" instances only receiving data from "N" instances broadcasting data. "N" is not limited by the present document.

In the following, the ACT Services are described.

ACT Peripheral Service:

- A Peripheral Service, placed in a specific location, such as a supermarket corridor, a public toilet, a metro station, a fitness or hotel room etc. has the capability to transmit, using WiFi technology, the following information such as its unique WiFi identifier (also known as the MAC identifier BSSID) and its unique WiFi human-readable network name (also known as the WiFi identifier SSID).

The scope of this entity is to provide frequently with a configurable periodicity the BSSID identifier that permits the human to record the passage in a determined correlated area (e.g. a corridor, a metro station or a metro car, a restroom, an open garden, an office, etc.).

It shall broadcast its BSSID in order to allow the human handheld devices to record it, and by pattern matching, to discover the risk of having been infected by staying in its proximity area. It shall also broadcast its SSID (always starting with the "ACT-" prefix) in order to allow the ACT Smart Mobile Application to detect which related BSSID identifier should be memorized in the internal memory of the smartphone.

It shall be associated with one or more ACT Detection Service to allow the correlation of the detection of the contamination with the proximity area where the ACT Peripheral Service is deployed.

The entity is not linked to a particular virus: indeed it can be configurated by the ACT Local Service entity to work against any future pandemic virus.

ACT Detection Service:

- A Detection Service informs the one Local Services about the detection of the contamination in one of the proximity areas associated to one or many Peripheral Service.

The scope of this entity is to inform the ACT Local Service about the detection of the contamination in one of the proximity areas associated to one of the ACT Peripheral Service that belongs to it.

The biological process and the kind of test used to check the material for contamination (e.g. HEPA air filter, waste-water filter, dirty cleaning tools and water, etc.) are non-pertinent to the ACT Technical Specification: nevertheless the exchange of specific configuration and monitoring information related to the detection tools are supported.

It shall be associated with one or more ACT Peripheral Services.

It shall communicate the detection of a contamination to one ACT Local Services**.**

It shall exchange its monitoring and configuration information with the ACT Local Service, including means to exchange the information necessary to the management of the specific detection tool.

ACT Local Service:

- A Local Service receives the information from one or many Detection Services belonging to it and forwards this information to the Control Service (defined below).

The scope of this entity is to receive the information from the ACT Detection Service belonging to it and forwards this information to the ACT Control Service and receive the necessary indications, in order to behave according to the Public Health Authorities policies for the ACT Peripheral Services configuration of the BSSID and of the SSID identifiers.

It shall transmit to the ACT Control Service the BSSID identifier of the ACT Peripheral Service involved in all test detections, together with their location.

It shall exchange its monitoring and configuration information with the ACT Control Service.

ACT Control Service:

- A Control Service will receive the information from all the Local Services related to Detection Services located in the area of pertinence of the Control Service, and will provide to it information, according to the Public Health Authorities policies. It will exchange its monitoring and configuration information with the one or many Local Services and with the many ACT Smart Mobile and ACT Display Application. It will coordinate and communicate the information about the areas of detection of the virus in other Municipalities, Departments, Regions, or Nations via others Control Services. This enables ACT to be a genuine, fully-fledged forecast tool.

The scope of this entity is mainly receive the information from the ACT Local Services related to contaminations according to the Public Health Authority policies. The ACT Control Service also represents the point of interaction with the ACT users.

It shall provide, upon request, the identifier of the one or several ACT Peripheral Services announcing contamination to the ACT Smart Mobile Application with additional information about indications and suggestions according to the Public Health Authority policies (e.g. the suggestion of avoiding certain areas or to perform a human test verification if certain conditions of exposure are met according to the detection of the virus in the areas covered by one or many ACT Peripheral Services).

ACT Smart Mobile Application:

- An ACT Smart Mobile Application is the digital tool available to the users to monitor the level of contamination. It collects the identifier from the one or many Peripheral Services and periodically compares it with the identifier-related published by the Control Service, with an associated time and with a forecast, synthetized with the help of the Public Health Authority, about potential contaminated areas.

The scope of this entity is mainly receive the information from the ACT Control Service, collect the identifiers from the ACT Peripheral Services and periodically compares this information with the ones from the ACT Control Services about the contaminated areas.

ACT Display Application:

- An ACT Display Application is hosted by an internet-connected device (Tablet, Personal Computer, Smart TV, etc.) that communicate with the Control Service to query and receive feedback about the status of the situation in specific geographical areas. By delegation, it can also query other Inter-Control Services.

It shall support the user about the discovery of its own risk according to area of interest, e.g. location visited in the past or areas planned to be visited in the future. It does not collect any BSSID information about the visited Access Points.

5.2 ACT messages

5.2.1 Service Identifiers

The identifiers of the ACT Detection Service, the ACT Local Service, the ACT Control Service (respectively the DETECTION-SERVICE-ID, the LOCAL-SERVICE-ID, the CONTROL-SERVICE-ID) shall map to the corresponding AE-ID of the oneM2M communication services and adopt their format. These identifiers do not need to be explicitly transmitted as part of the ACT protocol because are already part of the ACT Communication Framework. The mapping of the ACT Service with the ACT Communication Framework is specified in Clauses 5.3, 5.4 and 5.5 of the present document.

The PERIPHERAL-SERVICE-ID is defined in Clause 5.2.2 of the present document.

5.2.2 Information broadcasted by ACT Peripheral Service (and listened by ACT Smart Mobile Application)

The ACT Peripheral Service shall broadcast the information specified in the following Table 5.2.2-1.

Table 5.2.2-1

Parameter name	Type	Description
PERIPHERAL-SERVICE-ID	STRING	The identifier depends on the communication technology used. The identifier of the supported technology is defined in this clause below the table.

The transmission technology supported by the ACT Peripheral Service is WLAN (WiFi) according to IEEE 802.11 [2]. The ACT Peripheral Service is broadcasted by a commercial WiFi Access Point, and the string of the PERIPHERAL-SERVICE-ID shall be the BSSID [2], i.e. the string corresponding to the MAC address of the WiFi Access Point of the ACT Peripheral Services. In this case, the SSID [2] of the Access Point configured by the ACT Local Service shall contain the prefix "ACT-", and it shall be composed by the concatenation of the string "ACT-" with a string set according to the deployment needs. This allows the ACT Smart Mobile Application to decide (by filtering among the different detected SSID) which BSSID would be memorized among the many ones of the different WiFi Access Points detected. When detecting the BSSID/SSID, the ACT Smart Mobile Application shall memorize in its internal memory a record containing:

- the BSSID [2];
- the time TIMEIN (calculated internally by the mobile device and representing the time of when the BSSID/SSID is detected); and
- the time TIMEOUT (calculated internally by the mobile device and representing the time of when the BSSID/SSID signal is lost).

A short temporary loss of the ACT Peripheral Service signal should not be considered as an interruption of the presence of the mobile device under the coverage of the ACT Peripheral Service.

The ACT Peripheral Service signal should be tuned to be detectable as valid by an ACT Smart Mobile Application as much as reasonably possible according to the intended coverage area; moreover, the ACT Peripheral Service signal should not be detectable as valid outside the premises of the organization where the ACT Peripheral Service is installed.

Other transmission technologies are intended for consideration in future versions of the present document.

5.2.3 Information exchanged between ACT Detection Service and ACT Local Service

The ACT Detection Service shall transmit to the ACT Local Service the information specified in the following Table 5.2.3-1.

Table 5.2.3-1

Parameter name	Type	Description
STATUS	It is defined by one of the following STRING values: ACTIVE SLEEPING OUT-OF-SERVICE RESTARTING MAINTENANCE-REQUESTED FAULT	This parameter shall be mapped according to the following: ACTIVE: the Detection Service is operative; SLEEPING: the Detection Service has the energy saving status activated (e.g. when the associated shop is currently closed); OUT-OF-SERVICE: the Detection Service is still connected but it cannot become operative (e.g. it is subject to a maintenance procedure); RESTARTING: the Detection Service is in the process of becoming operative; MAINTENANCE-REQUESTED: the Detection Service require a maintenance (e.g. for the refilling of the test reagents, for the calibration, or for other tuning reasons); FAULT: the Detection Service has found itself to be faulty.
TEST-TIME	Time as defined in ISO 8601 [3].	The time of the collection of the test sample shall be reported in the TEST-TIME parameter. This parameter is absent if the Detection Service answers to a STATUS command and there is no TEST-RESULT to be reported.
TEST-RESULT	It is defined by one of the following NATURAL values: 0 ... 100.	This parameter shall be mapped according to the following: 0: No Virus detected; 1 to 100: Virus detected with an indication of the level of contamination of the sample. This parameter may be absent when the Detection Service answers to a STATUS command and there are not TEST-RESULTS to be reported.

The ACT Local Service shall transmit to the ACT Detection Service the information specified in the following Table 5.2.3-2.

Table 5.2.3-2

Parameter name	Type	Description
COMMAND	It is defined by one of the following STRING values: RESTART SHUTDOWN SLEEP STATUS-REQUEST TEST-START TEST-STOP	This parameter shall be mapped according to the following: RESTART: the Detection Service shall restart; SHUTDOWN: the Detection Service shall shutdown; SLEEP: the Detection Service shall activate the energy saving status; STATUS-REQUEST: The detection service shall respond providing the STATUS Parameter; TEST-START: the Detection Service shall initiate performing the tests, according to the given TEST-INTERVAL indication; TEST-STOP: the Detection Service shall stop performing the tests.
TEST-INTERVAL	NATURAL	This parameter shall be mapped according to the following: 0: the test shall be executed continuously; 1 to N: time interval, expressed in seconds, from the time of the last test if available; in case the time from the last test is not available, the test shall be executed immediately.

5.2.4 Information exchanged between ACT Local Service and ACT Peripheral Service

The ACT Peripheral Service is based on the WiFi technology with a commercial WiFi Access Point. The BSSID and the SSID identifiers of the Access Point are configured by the ACT Local Service as described in Clause 5.2.2 of the present document.

Other transmission technologies are intended for consideration in future versions of the present document.

5.2.5 Information exchanged between ACT Local Service and ACT Control Service

The ACT Local Service shall transmit to the ACT Control Service the information specified in the following Table 5.2.5-1.The LOCATION of a specific PERIPHERAL-SERVICE-ID shall be sent only at the initialization and at any change of LOCATION parameter.

The LOCAL-SERVICE-INFO optional parameter may be present in the case that the ACT Local Service intends to make available to the ACT Smart Mobile Application additional customized information via a dedicated URL. It may be sent at the initialization and at any change of the LOCAL-SERVICE-INFO parameter. As an example, it may contain the same information contained in a QR-code available locally at the ACT Local Service premises, or it may contain dynamic customized information associated to the specific ACT Peripheral Service.

The DISINFECTION/DISINFECTION-TIME parameter couple may be associated (or not) to a TEST-RESULT/TEST-TIME parameter couple.

Table 5.2.5-1

Parameter name	Type	Description
PERIPHERAL-SERVICE-ID	Defined in Clause 5.2.2.	Defined in Clause 5.2.2.
LOCAL-SERVICE-INFO	URL	URL pointing to customized information provided by the Local Service.
LOCATION	STRING	It shall contain the geographical area, represented using the Geohash Geocode System [26] of the place where the sample reported in the provided TEST-RESULT has been taken.
LOCAL-SERVICE-INFO	URL	URL pointing to customized information provided by the Local Service (valid for that specific Peripheral Service).
TEST-RESULT	Defined in Clause 5.2.3.	Defined in Clause 5.2.3.
TEST-TIME	Defined in Clause 5.2.3.	Defined in Clause 5.2.3.
DISINFECTION	BOOLEAN	TRUE indicates that: • active virus is not expected to be present; and • traces of not active virus have been reasonably removed.
DISINFECTION-TIME	Time as defined in ISO 8601 [3].	Time of completion of the disinfection.

5.2.6 Information exchanged between ACT Smart Mobile Application and ACT Control Service

The ACT Smart Mobile Application shall periodically send a query the ACT Control Service for providing the information specified in the following Table 5.2.6-1. The periodicity of the request is configured in the application, and can be modified by the ACT Control Service by means of application software version upgrades.

The precise geographical position of the smartphone shall not be transmitted to the ACT Control Service. In case of absence of underlay network connectivity, the ACT Smart Mobile Application will keep track of all visited geographical areas, and, as soon as the network connectivity will be available, the ACT Smart Mobile Application will issue a sequence of queries related with such areas.

The CONTROL-SERVICE-IDs are configured in the ACT Smart Mobile Application: many CONTROL-SERVICE-IDs can be then stored in the ACT Smart Mobile Application; this allow to correlate the ACT Control Service with the given Municipality/Department/Region/Country it is currently depending in.

Table 5.2.6-1

Parameter name	Type	Description
QUERY	STRING	It shall contain the geographical area represented using the Geohash Geocode System [26]. It includes the area visited by the device hosting the Smart Mobile Application.

The ACT Control Service shall respond to the ACT Smart Mobile Application with a list of replies specified in the following Table 5.2.6-2, where each reply is defined in Table 5.2.6-3. Each element corresponds to an ACT Peripheral Service that:

- geographically belongs to the geographical area indicated in the received QUERY;
- is associated to a positive virus detection (the period under consideration is defined by the ACT Control Service).

The response also includes the time periods of RED-FORECASTS associated to each of the reported PERIPHERAL-SERVICE-ID. The relevance of the contamination is assessed by the ACT Control Services according to Public Health Authority policies; only RED cases are reported.

The MESSAGE parameter may be included as an optional text message by the ACT Control Service and, when present, shall be displayed to the user of the ACT Smart Mobile Application.

The LOCAL-SERVICE-INFO parameter (described in Clause 5.2.5) is sent to the ACT Control Service that relays it to the ACT Smart Mobile Applications within the REPLIES information parameter.

The CONTROL-SERVICE-INFO optional parameter may be present in the case that the ACT Control Service intends to make available to the ACT Smart Mobile Application additional customized information via a dedicated URL.

Table 5.2.6-2

Parameter name	Type	Description
REPLIES	LIST OF REPLY	List of replies indicating the Peripheral Services with the related RED forecasts. Defined in Table 5.2.6-3.
MESSAGE	STRING	When present, it shall be displayed by the Smart Mobile Application to provide guidance to the users.

In the above table the REPLY record-type is composed by a PERIPHERAL-SERVICE-ID, RED-FORECASTS, LOCAL-SERVICE-INFO, and a CONTROL-SERVICE-INFO, and it is defined in Table 5.2.6-3.

Table 5.2.6-3

Type	Field name	Type	Description
REPLY	PERIPHERAL-SERVICE-ID	Defined in Clause 5.2.2.	Defined in Clause 5.2.2.
	RED-FORECASTS	LIST of RED-FORECAST	List of RED forecast frames. Defined in Table 5.2.6-4.
	LOCAL-SERVICE-INFO	URL	URL pointing to customized information provided by the Local Service (valid for that specific Peripheral Service).
	CONTROL-SERVICE-INFO	URL	URL pointing to customized information provided by the Control Service (valid for that specific Peripheral Service).

In the above table the RED-FORECAST record-type is composed by a time FRAME, and it is defined in Table 5.2.6-4.

Table 5.2.6-4

Type	Field name	Type	Description
RED-FORECAST	FRAME	(Time,Time) as defined in ISO 8601 [3].	This parameter indicates the RED time frame of the corresponding Peripheral Service.

Additionally, user tested positive to the virus may instruct the ACT Smart Mobile Application, to inform the ACT Control Service of the potential contamination of visited locations, by sending the information described in Table 5.2.6-5.

Table 5.2.6-5

Parameter name	Type	Description
PERSONAL-TEST-TIME	Time as defined in ISO 8601 [3].	The time when the smartphone user has been tested positive to the virus (i.e. the time when the sample was taken).
PERSONAL-TEST-CODE	STRING	Reference ensuring that the test is recognized by the Public Health Authority. The format is defined by the Public Health Authority.
VISITED-BSSIDS	LIST OF PERIPHERAL-SERVICE-ID	The PERIPHERAL-SERVICE-ID is defined in Clause 5.2.2.

5.2.7 Information exchanged between ACT Display Application and ACT Control Service

The web-based ACT Display Application (Personal Computer, Tablet, Smart TV, etc.) sends queries to the ACT Control Service for providing information. The parameters are specified in the following Table 5.2.7-1.

Table 5.2.7-1

Parameter name	Type	Description
QUERY	STRING	Geographical area of interest represented using the Geohash Geocode System [26].
FORECAST-FRAME	((Time, Time), STRING) as defined in ISO 8601 [3].	It shall contain two Times, i.e. the time-interval for which a forecast is queried and a STRING that can be: • RED in case the query is asking only for notifying PERIPHERAL-ID with RED forecast; • ALL in case the query is asking for notifying PERIPHERAL-ID with all the kind of forecast.

The ACT Control Service shall respond to the ACT Display Application with a list of replies specified in the following Table 5.2.7-2, where each reply is defined in Table 5.2.7-3.

The relevance of the contamination is assessed by the ACT Control Services according to Public Health Authorities policies.

Table 5.2.7-2

Parameter name	Type	Description
REPLIES	LIST OF REPLY	List of replies indicating the Peripheral Services with the related forecasts. Defined in Table 5.2.7-3.
MESSAGE	STRING	When present, it shall be displayed by the Display Application to provide guidance to the users.

In the above table the REPLY record-type is composed by a DETECTION_AREA and a FORECASTS, and it is defined in Table 5.2.7-3.

Table 5.2.7-3

Type	Field name	Type	Description
REPLY	DETECTION_AREA	STRING	Geographical area of application of associated forecast, represented using the Geohash Geocode System [26].
	FORECASTS	LIST OF FORECAST	List of FORECAST associated to the DETECTION_AREA.

In the above table the FORECAST record-type is composed by a FORECAST_COLOR and a time FRAME, and it is defined in Table 5.2.7-4.

Table 5.2.7-4

Type	Field name	Type	Description
FORECAST	FORECAST_COLOR	It is defined by one of the following STRING values: GREY GREEN YELLOW RED	The meaning of each color code is defined by the Public Health Authority.
	FRAME	(Time,Time) as defined in ISO 8601 [3].	This parameter indicates the time frame of the FORECAST.

The UX/UI of the ACT Display Application may be able to draw some "animation" of the evolving situation between the required time frame. Optionally, the following parameter may be added to the list, as specified in the following Table 5.2.7-5.

Table 5.2.7-5

Parameter name	Type	Description
MESSAGE	STRING	Used by the Control Service to provide information and guidance to the users of the Display Application.

5.2.8 Information exchanged between different ACT Control Services

The ACT Control Services should be able to communicate each other's to share the ACT related information across the domains of the different Public Health Authorities. The ACT Control Service may query each other's, as specified in the following Table 5.2.8-1.

Table 5.2.8-1

Parameter name	Type	Description
QUERY	STRING	Geographical area of application of query, represented using the Geohash Geocode System [26].

The target ACT Control Service(s) is(are) selected according to the geographical area of competence, and the query is then sent on the corresponding communication framework interface (i.e. the oneM2M Mcc' API).

The ACT Control Service shall respond with a list of replies specified in the following Table 5.2.8-2, where each reply is defined in Table 5.2.8-3.

The relevance of the contamination is assessed by the relevant ACT Control Services according to relevant Public Health Authorities policies.

Table 5.2.8-2

Parameter name	Type	Description
REPLIES	LIST OF REPLY	List of replies indicating the Peripheral Services with the related forecasts. Defined in Table 5.2.7-3.
MESSAGE	STRING	When present, it provide guidance between Control Services.

In the above table the REPLY record-type is composed by a PERIPHERAL-SERVICE-ID, DETECTION_AREA, and a FORECASTS, and it is defined in Table 5.2.8-3.

Table 5.2.8-3

Type	Field name	Type	Description
REPLY	PERIPHERAL-SERVICE-ID	Defined in Clause 5.2.2.	Defined in Clause 5.2.2.
	DETECTION_AREA	STRING	Geographical area of application of associated forecast, represented using the Geohash Geocode System [26].
	FORECASTS	LIST OF FORECAST	List of FORECAST associated to the DETECTION_AREA.

In the above table the FORECAST record-type is composed by a FORECAST_COLOR and a time FRAME, and it is defined in Table 5.2.8-4.

Table 5.2.8-4

Type	Field name	Type	Description
FORECAST	FORECAST_COLOR	It is defined by one of the following STRING values: GREY GREEN YELLOW RED	The meaning of each color code is defined by the Public Health Authority.
	FRAME	(Time,Time) as defined in ISO 8601 [3].	This parameter indicates the time frame of the FORECAST.

5.3 oneM2M Resources to implement the ACT Services

The element of the ACT make use of oneM2M specification to support communication and interoperability. oneM2M specification are formally and normatively referenced in Clause 6, while more information and tutorials are available on the oneM2M website www.oneM2M.org. For a correct understanding of the oneM2M use in the contest of the present documents, it is recommended to start becoming familiar with the oneM2M architecture and following oneM2M concepts:

- Nodes: ADN, ASN, IN.
- Entities: AE, CSE, IPE.
- Reference points/API: Mca, Mcc, Mcc'.

Figure 5.3-1 below provide an example of association between ACT elements and the oneM2M Entities with the oneM2M relevant reference points.

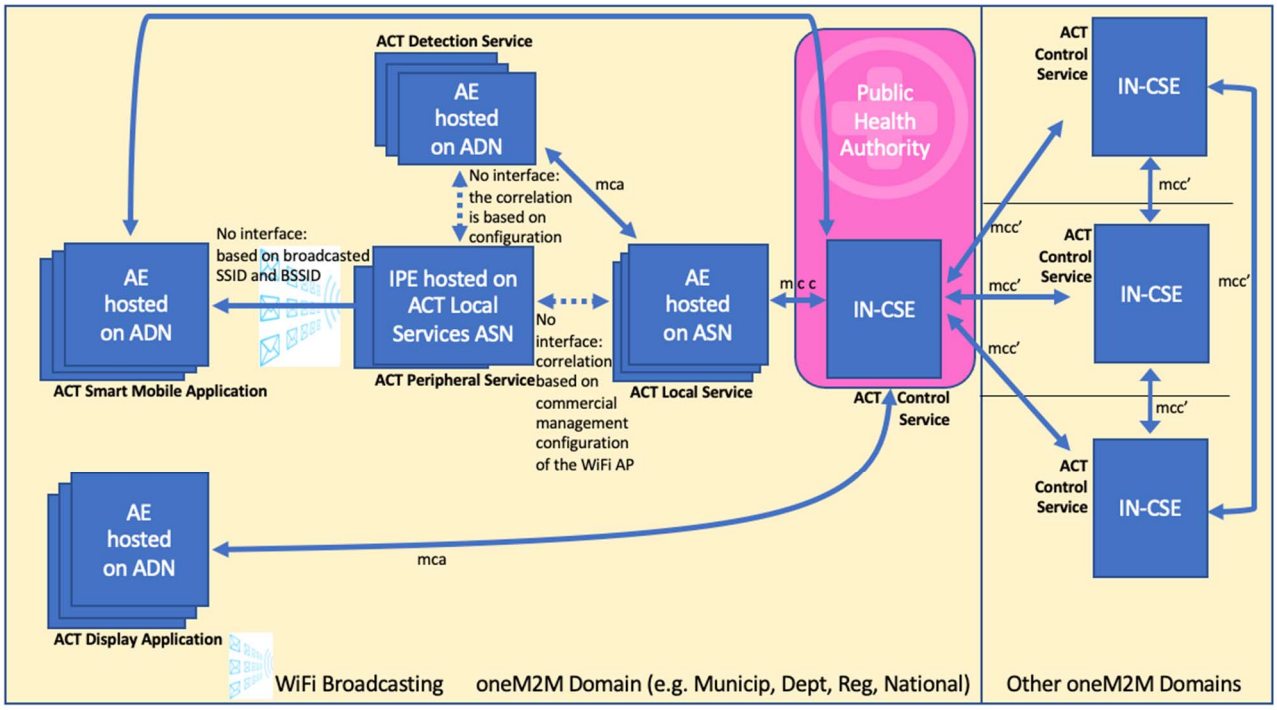


Figure 5.3-1: Mapping of the ACT Architecture in the common oneM2M Framework

The ACT elements shall comply to the mappings identified in the following Table 5.3-1.

Table 5.3-1: Mapping of ACT on oneM2M Elements and Reference Points

	ACT Smart Mobile Application	ACT Display Application	ACT Peripheral Service	ACT Detection Service	ACT Local Service	ACT Control Service
ACT Smart Mobile Application Mapped on: oneM2M AE (hosted on ADN)			Non oneM2M interface (Based on broadcasted SSID and BSSID)			Mca
ACT Display Application Mapped on: oneM2M AE (hosted on ADN)						Mca
ACT Peripheral Service Not a oneM2M node, It is mapped by an IPE hosted on ACT Local Services ASN					Non oneM2M interface (The interface is based on commercial management configuration of the WiFi Access Points)	
ACT Detection Service Mapped on: oneM2M AE (hosted on ADN)					Mca	
ACT Local Service Mapped on: oneM2M AE (hosted on ASN)						Mcc
ACT Control Service IN-CSE						Mcc'

5.4 Security, Privacy and Cybersecurity support

The security of the Asynchronous Contact Tracing architecture is assured by the oneM2M Communication Framework (the oneM2M system) referenced in Clause 6. The oneM2M system provide a complete solution for modular security (communication, identification, etc.) and flexible granularity of data access control (access control via identifiers, roles, tokens, etc.). Please refer to the oneM2M system specifications, in particular [4] (ETSI TS 118 103 [8]: oneM2M; Security solutions).

These capabilities empower the Asynchronous Contact Tracing with the ability to satisfy privacy and cybersecurity needs from the market and from the regulation authorities.

5.5 Management support

The management of the components of the Asynchronous Contact Tracing architecture, in particular the remoted components at the edges of the systems, is assured by the communication framework (the oneM2M system) referenced in Clause 6. The oneM2M system provide a flexible solution for management including function such as security configuration and Software updates. Refer to the oneM2M system specifications.

6 Asynchronous Contact Tracing oneM2M Communication Framework

6.1 Introduction

The oneM2M specifications define a framework for the communication and sharing of information. The major paradigm can be referred to as "store & share". *De facto* any object and information is mapped to resources that can be shared, discovered and accessed via a resource-oriented architecture and its related protocols.

IP protocols and URI formats are at the basis of the communication and identification, making the solution Internet of Things friendly, so the oneM2M system is a component of IoT.

The following three aspects most characterize the oneM2M solution in the context of ACT:

- The mentioned store & share mechanism allows information sharing among multiple services, without consuming the data or explicitly addressing the interested applications. In fact, the use of a communication that allows the storage of the information (on devices, gateways and servers) and its retrieval using application identities, removes the need for end to end routing of the information.
- A clear separation between security and privacy, where security is based on existing security mechanisms, while privacy is enforced by the system flexibly determined by the service application. The service application may decide to which applications/applications sets and under which conditions they choose to share the information.
- Transparency with respect to the application semantics. Data is stored and retrieved transparently from the point of view of the communication framework, which knows very little or nothing about the nature of the data contained and its format. This implies that to provide a full communication interoperability at the application level the service application needs to share a semantic model or to interwork with a common semantic model. In the case of ACT the common semantics are defined in ETSI TS 103 264 [24].

Everything is then integrated with the required communication feature: among others, security, device management, group managements, location management, communication scheduling, etc., are all part of the oneM2M solution. An intelligent independence from the underlying network: multiple IP based networks can be used, and the M2M System is used to hide (or abstract) the data with respect to the applications. This tries to make conscious & efficient use of the available connectivity means, with the possibility of reusing underlying network functionality where available.

Additionally, the oneM2M Communication Framework allows a flexible deployment. It is designed as a distributed system, where the functionalities and information can be distributed on devices, gateways and centralized servers, according to the specific service needs and optimizations.

6.2 Asynchronous Contact Tracing Communication Framework

The Communication Framework for ACT shall comply with the following specifications:

NOTE: For oneM2M specifications for which the transposition process by ETSI is still ongoing at the date of the present document, only the oneM2M number is provided.

- ETSI TS 118 111 (oneM2M TS-0011) [5].
- ETSI TS 118 102 (oneM2M TS-0002) [6].
- ETSI TS 118 101 (oneM2M TS-0001) [1].
- ETSI TS 118 104 (oneM2M TS-0004) [7].
- ETSI TS 118 103 (oneM2M TS-0003) [8].
- ETSI TS 118 105 (oneM2M TS-0005) [9].
- ETSI TS 118 106 (oneM2M TS-0006) [10].
- ETSI TS 118 109 (oneM2M TS-0009) [11].
- ETSI TS 118 120 (oneM2M TS-0020) [12].
- ETSI TS 118 112 (oneM2M TS-0012) [13].
- ETSI TS 118 115 (oneM2M TS-0015) [14].
- ETSI TS 118 113 (oneM2M TS-0013) [15].
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- ETSI TS 118 116 (oneM2M TS-0016 [17]).
- ETSI TS 118 132 (oneM2M TS-0032) [18].
- ETSI TS 118 126 (oneM2M TS-0026) [19].
- oneM2M TS-0030 [20].
- oneM2M TS-0031 [21].
- oneM2M TS-0033 [22].
- oneM2M TS-0034 [23].

The communication framework security may be omitted when reusing an underlying network security (e.g. when the communication is performed on a secure cellular network).

Any proprietary addition/extension to the protocols on Mca, Mcc and Mcc' shall not be included (i.e. no proprietary parameter or resource is admitted on these interfaces). Proprietary extensions may be included by means of specialized applications that operate by associating semantic means to the standard resources (typically application and containers as defined in ETSI TS 118 101 [1]). This acts as plug in on the communication framework without impacting the communication framework interoperability.

These specifications apply to all the entities in the Asynchronous Contact Tracing Communication Framework including the Asynchronous Contact Tracing themselves.

Additional guideline and information are included in ETSI TR 118 501 [i.16], ETSI TR 118 525 [i.17], ETSI TR 118 535 [i.18], and ETSI TR 118 545 [i.19].

Annex A (normative): ACT Messages Specification

A.1 Information exchanged between Detection Service and Local Service

```
ACTDetectionServiceToACTLocalServiceMessage:
      type: object
      required:
        - Status
        - Test-Time
        - Test-Result
      properties:
        Status:
          type: string
          enum:
            - Active
            - Sleeping
            - Out-Of-Service
            - Restarting
            - Maintenance-Requested
            - Fault
        Test-Time:
          type: string
          format: date-time
          example: '2021-07-08T11:28:27.176750'
          description: "ISO 8601 time format"
        Test-Result:
          type: integer
          minimum: 0
          maximum: 100
          example: 3

ACTLocalServiceToACTDetectionServiceMessage:
      type: object
      required:
        - Command
        - Test-Interval
      properties:
        Command:
          type: string
          enum:
            - Restart
            - Shutdown
            - Sleep
            - Status-Request
            - Test-Start
            - Test-Stop
        Test-Interval:
          type: integer
          minimum: 0
          example: 3
          description: "Test interval in seconds"
```

A.2 Information exchanged between Local Service and Peripheral Service

```
PeripheralServiceMessage:
      type: object
      properties:
        Peripheral-Service-Id:
          type: string
          example: 'C8:60:00:4C:27:A5'
          description: "The identifier depends on the communication technology used"
```

A.3 Information exchanged between Local Service and National Control Service

```
ACTLocalToACTNCServiceMessage:
      type: object
      required:
        - Peripheral-Service-Id
        - Location
        - Location-Service-Info
        - Test-Result
        - Test-Time
        - Disinfection
        - Disinfection-Time
      properties:
        Peripheral-Service-Id:
          type: string
          example: 'C8:60:00:4C:27:A5'
          description: "The identifier depends on the communication technology used"
        Location:
          type: string
          example: 'ezs42e44yx96'
          description: "The geographical area, represented using the Geohash Geocode System"
        Location-Service-Info:
          type: string
          example: 'https://NationalHealth.com/forecast'
          description: "URL pointing to customized information provided by the Local Service"
        Test-Result:
          type: integer
          minimum: 0
          maximum: 100
          example: 3
        Test-Time:
          type: string
          format: date-time
          example: '2021-07-08T11:28:27.176750'
          description: "ISO 8601 time format"
        Disinfection:
          type: boolean
          example: true
        Disinfection-Time:
          type: string
          format: date-time
          example: '2021-07-08T11:28:27.176750'
          description: "ISO 8601 time format"
```

A.4 Information exchanged between Smart Mobile Application and National Control Service

```
ACTSmartAppToACTNCServiceQuery:
      type: string
      example: 'ezs42e44yx96'
      description: "The geographical area represented using the Geohash Geocode System"
```

```
ACTNCServiceToACTSmartAppQueryResponse:
      type: object
      required:
        - Replies
        - Message
      properties:
        Replies:
          type: object
          required:
            - Peripheral-Service-Id
            - RED-Forecasts
            - Local-Service-Info
            - Control-Service-Info
          properties:
            Peripheral-Service-Id:
              type: string
              example: 'C8:60:00:4C:27:A5'
              description: "The identifier depends on the communication technology used"
            RED-Forecasts:
              type: object
              required:
                - start
                - end
              properties:
                start:
                  type: string
                  format: date-time
                  example: '2021-07-08T11:28:27.176750'
                  description: "Time frame start"
                end:
                  type: string
                  format: date-time
                  example: '2021-07-08T11:28:27.176750'
                  description: "Time frame end"
            Local-Service-Info:
              type: string
              example: 'https://LocalHealth.com/forecast'
              description: "URL pointing to customized information provided by the Local Service"
            Control-Service-Info:
              type: string
              example: 'https://NationalHealth.com/forecast'
              description: "URL pointing to customized information provided by the Control Service"
        Message:
          type: string
          example: 'The area is infected, please get ASAP a PCR test or go to isolation'
          description: "It shall be displayed by the Smart Mobile Application to provide
                        guidance to the users"
```

```
ACTSmartAppToACTNCServiceMessage:
      type: object
      required:
        - Personal-Test-Time
        - Personal-Test-Code
        - Visited-BSSIDS
      properties:
        Personal-Test-Time:
          type: string
          format: date-time
          example: '2021-07-08T11:28:27.176750'
          description: "The time when the smartphone user has been tested positive to the virus"
        Personal-Test-Code:
          type: string
          example: 'T23569K34'
          description: "Reference ensuring that the test is recognized by the Public Health
                        Authority"
        Visited-BSSIDS:
          type: array
          items: {$ref : '#/components/schemas/PeripheralServiceMessage'}
          description: "The peripheral devices user smartphone recorded"
```

A.5 Information exchanged between Display Application and National Control Service

```
ACTDisplayApplicationToACTNCServiceQuery:
      type: object
      required:
        - Query
        - Forecast-Frame
      properties:
        Query:
          type: string
          example: 'ezs42e44yx96'
          description: "Geographical area of interest represented using the Geohash Geocode System"
        Forecast-Frame:
          type: object
          required:
            - start
            - end
            - Forecast
          properties:
            start:
              type: string
              format: date-time
              example: '2021-07-08T11:28:27.176750'
              description: "Time frame start"
            end:
              type: string
              format: date-time
              example: '2021-07-08T11:28:27.176750'
              description: "Time frame end"
            Forecast:
              type: string
              example: 'RED'
              description: "RED in case the query is asking only for notifying PERIPHERAL-ID with
                            RED forecast; ALL in case the query is asking for notifying
                            PERIPHERAL-ID with all the kind of forecast"
```

```
ACTNCServiceToACTDisplayApplicationQueryResponse:
      type: object
      required:
        - Replies
        - Message
      properties:
        Replies:
          type: object
          required:
            - Detection-Area
            - Forecasts
            - Forecast
          properties:
            Detection-Area:
              type: string
              example: 'ezs42e44yx96'
              description: "Geographical area of application of associated forecast,
                            represented using the Geohash Geocode System"
            Forecasts:
              type: array
              items: {$ref: '#/components/schemas/Forecast'}
              description: "The list of forecast associated to the detection_area"
            Forecast:
              type: object
              required:
                - Forecast-Color
                - Frame
              properties:
                Forecast-Color:
                  type: string
                  enum:
                    - Green
                    - Grey
                    - Yellow
                    - Red
                  example: 'Red'
                  description: "Contamination level each color code is defined by the
                                Public Health Authority"
                Frame:
                  type: object
                  required:
                    - start
                    - end
                  properties:
                    start:
                      type: string
                      format: date-time
                      example: '2021-07-08T11:28:27.176750'
                      description: "Time frame start"
                    end:
                      type: string
                      format: date-time
                      example: '2021-07-08T11:28:27.176750'
                      description: "Time frame end"
        Message:
          type: string
          example: 'Message from National Health Service'
          description: "Used by the Control Service to provide information and
                        guidance to the users of the Display Application"
```

A.6 Information exchanged between different National Control Services

```
ACTNCServiceToACTNCServiceQuery:
      type: object
      required:
        - Query
      properties:
        Query:
          type: string
          example: 'ezs42e44yx96'
          description: "Geographical area of the National service represented using
                        the Geohash Geocode System"


ACTNCServiceToACTNCServiceQueryResponse:
      type: object
      required:
        - Replies
        - Message
      properties:
        Replies:
          type: object
          required:
            - Peripheral-Service-Id
            - Detection-Area
            - Forecasts
            - Forecast
          properties:
            Peripheral-Service-Id:
              type: string
              example: 'C8:60:00:4C:27:A5'
              description: "The identifier depends on the communication technology used"
            Detection-Area:
              type: string
              example: 'ezs42e44yx96'
              description: "Geographical area of application of associated forecast,
                            represented using the Geohash Geocode System"
            Forecasts:
              type: array
              items: {$ref: '#/components/schemas/Forecast'}
              description: "The list of forecast associated to the detection_area"
            Forecast:
              type: object
              required:
                - Forecast-Color
                - Frame
              properties:
                Forecast-Color:
                  type: string
                  enum:
                    - Green
                    - Grey
                    - Yellow
                    - Red
                  example: 'Red'
                  description: "Contamination level each color code is defined by the
                                Public Health Authority"
                Frame:
                  type: object
                  required:
                    - start
                    - end
                  properties:
                    start:
                      type: string
                      format: date-time
                      example: '2021-07-08T11:28:27.176750'
                      description: "Time frame start"
                    end:
                      type: string
                      format: date-time
                      example: '2021-07-08T11:28:27.176750'
                      description: "Time frame end"
```

```
Message:
  type: string
  example: 'Message from National Health Service'
  description: "When present, it provide guidance between Control Services"
```

Annex B (informative): JSON messages examples

B.1 Information exchanged between Detection Service and Local Service

```
ACTDetectionServiceToACTLocalServiceMessage:
{
  "Status": "Active",
  "Test-Time": "2021-07-08T11:28:27.176750",
  "Test-Result": 3
}

ACTLocalServiceToACTDetectionServiceMessage:
{
  "Command": "Restart",
  "Test-Interval": 3
}
```

B.2 Information exchanged between Local Service and Peripheral Service

```
{
  "Peripheral-Service-Id": "C8:60:00:4C:27:A5"
}
```

B.3 Information exchanged between Local Service and National Control Service

```
ACTLocalToACTNCServiceMessage:
{
  "Peripheral-Service-Id": "C8:60:00:4C:27:A5",
  "Location": "ezs42e44yx96",
  "Location-Service-Info": "https://NationalHealth.com/forecast",
  "Test-Result": 3,
  "Test-Time": "2021-07-08T11:28:27.176750",
  "Disinfection": true,
  "Disinfection-Time": "2021-07-08T11:28:27.176750"
}
```

B.4 Information exchanged between Smart Mobile Application and National Control Service

```
ACTSmartAppToACTNCServiceQuery:
{
  "ACTSmartAppToACTNCServiceQuery": "ezs42e44yx96"
}
ACTNCServiceToACTSmartAppQueryResponse:
{
  "Replies": {
    "Peripheral-Service-Id": "C8:60:00:4C:27:A5",
    "RED-Forecasts": {
      "start": "2021-07-08T11:28:27.176750",
      "end": "2021-07-08T11:28:27.176750"
    },
    "Local-Service-Info": "https://LocalHealth.com/forecast",
    "Control-Service-Info": "https://NationalHealth.com/forecast"
  },
  "Message": "The area is infected, please get ASAP a PCR test or go to isolation"
}
```

```
ACTSmartAppToACTNCServiceMessage:
{
  "Personal-Test-Time": "2021-07-08T11:28:27.176750",
  "Personal-Test-Code": "T23569K34",
  "Visited-BSSIDS": [
    {
      "Peripheral-Service-Id": "C8:60:00:4C:27:A5"
    }
  ]
```

B.5 Information exchanged between Display Application and National Control Service

```
ACTDisplayApplicationToACTNCServiceQuery:
{
  "Query": "ezs42e44yx96",
  "Forecast-Frame": {
    "start": "2021-07-08T11:28:27.176750",
    "end": "2021-07-08T11:28:27.176750",
    "Forecast": "RED"
  }
}


ACTNCServiceToACTDisplayApplicationqueryResponse:
{
  "Replies": {
    "Detection-Area": "ezs42e44yx96",
    "Forecasts": [
      {
        "Forecast-Color": "Green"
      }
    ],
    "Forecast": {
      "Forecast-Color": "Red",
      "Frame": {
        "start": "2021-07-08T11:28:27.176750",
        "end": "2021-07-08T11:28:27.176750"
      }
    }
  },
  "Message": "Message from National Health Service"
}
```

B.6 Information exchanged between different National Control Services

```
ACTNCServiceToACTNCServiceQuery:
{
  "ACTNCServiceTOACTNCServiceQuery": "ezs42e44yx96"
}

ACTNCServiceToACTNCServiceQueryResponse:
{
  "Replies": {
    "Peripheral-Service-Id": "C8:60:00:4C:27:A5",
    "Detection-Area": "ezs42e44yx96",
    "Forecasts": [
      {
        "Forecast-Color": "Green"
      }
    ],
    "Forecast": {
      "Forecast-Color": "Red",
      "Frame": {
        "start": "2021-07-08T11:28:27.176750",
        "end": "2021-07-08T11:28:27.176750"
      }
    }
  },
  "Message": "Message from National Health Service"
}
```

Annex C (informative): Bibliography

List of spare links about how extracting group testing from waste-water and air-conditioning:

About waste-water:

- https://www.bbc.com/news/uk-scotland-53109139.
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Other useful references not used in the present document:

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  NOTE: Available at https://www.gouvernement.fr/sites/default/files/document/document/2020/04/discours_de_m._edouard_philippe_premier_ministre_-_presentation_de_la_strategie_nationale_de_deconfinement_-_assemblee_nationale_-_28.04.2020.pdf.

- EitDigital: "Anonymous COVID-19 contact tracing using physical tokens".

  NOTE: Available at https://www.eitdigital.eu/newsroom/news/article/anonymous-covid-19-contact-tracing-using-physical-tokens/.

Annex D (informative): Change History

Date	Version	Information about changes
09/2020	V0.0.1	Early Draft
09/2020	V0.0.2	Changed TOC and added references
09/2020	V0.0.3	Added some contents
09/2020	V0.0.4	Few modifications
09/2020	V0.0.5	UK pass
09/2020	V0.0.6	Few modifications
10/2020	V0.0.7	Services and Flows V1.0
10/2020	V0.0.8	Protocol V0.1
10/2020	V0.0.9	Protocol V0.2
10/2020	V0.1.0	Protocol V0.3, proof reading + changed TOC
10/2020	V0.2.0	Protocol V0.4
10/2020	V0.2.1	Intro pass
11/2020	V0.2.2	Protocol V0.5
11/2020	V0.2.3	Protocol V0.6 + intro
11/2020	V0.3.0	Protocol V0.7
11/2020	V0.3.1	Protocol V0.7.1
11/2020	V0.3.2	Draft reviewed by ETSI Technical Officerto better comply with ETSI TS Skeleton and ready to be shared in PDF format (with Disclaimer in front page) in the Open Area
11/2020	V0.3.3	Protocol V0.8.. Better prose in Executive Summary, Introduction and Examples in Clause 5 and Clause 7
12/2020	V0.3.4	Protocol V0.9. Added examples: general pass of prose
12/2020	V0.3.5	Added comments
12/2020	V0.3.7	Polish and protocol adjustments
12/2020	V0.4.0	Protocol V1.0beta. Response to questions asked during the 14/12 meeting + Polish examples + New TOC + Add
12/2020	V0.4.1	Two tables added and amended two figures
12/2020	V1.1.1	Final Draft Approved by 15-18 December 2020 SmartM2M#56 Plenary reviewed by ETSI Technical Officer (from a fresh empty TS Skeleton) and submitted to EditHelp for Publication in URGENT mode
01/2021	V1.1.2	Editorial Modification Clause 5.3 (ACT in Tourism) and [i.12] bookmark suppressed on the express request of ETSI Technical Officer supported by TC SmartM2M Officials
01/2021	V2.0.0	New Work Item. Renamed ETSI TS 103757v1.1.1 in ETSI TS 103757v2.1.1. by ETSI
01/2021	V2.0.1	Moving Usecases in Annex C, doing a cleaning pass and shifting of all the document numbering
01/2021	V2.0.2	Editorial modifications agreed as a base line document during the 15/02/2021 ad hoc ACT meeting
02/2021	V2.2.0	Widrawn by ETSI due to bad numbering
02/2021	V2.2.1	CR 000030r2: Tiny optimization of the message exchange in Clause 5.2.5: messages between Local Service and National Control Service
02/2021	V2.2.2	CR 057015r2: Simplification of Appendix C4
03/2021	V2.3.1	CR 000075r1: new feature and 000075r1 restyling
04/2021	V2.3.2	CR 000091: Suppressed Annex C: (informative): Use Cases and Scenarios to running ACT→ Now Annex C contains the Bibliography
05/2021	V2.4.0	CR 000099r3 + CR 000106r2: Polish Clause 5.1 + Supporting the case of infrequent tests, and long time between the sampling and the test resulting
05/2021	V2.5.0	CR 0000119r1: Polish Clause 5.2.6: Clarifying the time when user has been tested positive to the virus
05/2021	V2.5.0	CR 0000120r2: Clarifying Disinfection meaning and Time
05/2021	V2.5.0	CR 0000130r1: Space illuminated and monitored, ensuring matching
05/2021	V2.5.0	CR 0000132r2: On attaching BSSID/SSID TIMEOUT in the record registered by the ACT Smart Mobile Application
05/2021	V2.6.0	CR 058032r1: Additional customized information and CR 058031: Efficient communications among ACT Control Services
06/2021	V2.7.0	CR 000146r1: Using Geohash Geocode System
06/2021	V2.7.1	CR : Final polishing
07/2021	V2.7.2	Final Draft: Annex A and B
07/2021	V2.7.3	Annex B: ~~Normative~~ → "Informative" + launch Remote Consensus

History

Document history		
V1.1.1	December 2020	Publication
V1.1.2	January 2021	Publication
V2.1.1	August 2021	Publication