Symbiosis of smart objects across IoT environments

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Final Data Management Plan

The symbIoTe Consortium

Intracom SA Telecom Solutions, ICOM, Greece
Sveučiliste u Zagrebu Fakultet elektrotehnike i računarstva, UNIZG-FER, Croatia
AIT Austrian Institute of Technology GmbH, AIT, Austria
Nextworks Srl, NXW, Italy
Consorzio Nazionale Interuniversitario per le Telecomunicazioni, CNIT, Italy
ATOS Spain SA, ATOS, Spain
University of Vienna, Faculty of Computer Science, UNIVIE, Austria
Unidata S.p.A., UNIDATA, Italy
Sensing & Control System S.L., S&C, Spain
Fraunhofer IOSB, IOSB, Germany
Ubiwhere, Lda, UW, Portugal
VIPnet, d.o.o, VIP, Croatia
Instytut Chemii Bioorganicznej Polskiej Akademii Nauk, PSNC, Poland
NA.VI.GO. SCARL, NAVIGO, Italy
Universität Zürich, UZH, Switzerland

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Editor(s):   Sergios Soursos

E-mail: souse@intracom-telecom.com

Author(s):   Sergios Soursos, Matteo Pardi, Mario Drobics, Raquel Ventura Miravet, Kurt Edegger, Aleksandar Antonic, Toni Paradell, Reinhard Herzog, Luca De Santis, Joao Garcia, Gerhard Duennebeil, Karl Kreiner, Gino Carrozzo

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1 Introduction

symbIoTe participates in the pilots on Open Research Data in Horizon 2020. To this end, the project will identify the research data to be made available via open access. These data can fall under three main categories: i) dissemination material, ii) software source code and iii) pilot/trial data. *Dissemination material* refers to all technical material that is published and may contain details on the project's work. *Software source code* refers to the source code of the middleware software that the project will design and implement, along with its documentation. Finally, the *pilot data* refer to all the raw or processed data that will be used as input in or produced by the envisioned pilots/trials of the project. Since symbIoTe is about interconnecting Internet of Things (IoT) platforms, a number of data and meta-data will be handled by the symbIoTe middleware. Part of these data can be made available to the research community, especially in the case where such data will be used to (numerically or through experiments) evaluate the mechanisms employed by the symbIoTe system in several scientific papers.

The final deliverable on Data Management provides updates on the procedures to collect, store and make available open access research data. Apart from the selection of the hosting platforms, it is important to identify what kind of data will be shared there. Moreover, the proper description of the data will facilitate their discovery by external researchers.

1.1 Structure of the document

Chapter 2 describes the dissemination material that will be available as open access and provides the details of the different categories for such data. Chapter 3 discusses how the software source code is made available to the developers' community. Chapter 4 highlights what pilot data will be collected, stored and accessed, while chapter 5 concludes this deliverable.

2 Dissemination Material

symbIoTe's dissemination material falls under the following main categories:

- Public deliverables
- Scientific papers
- Technical reports
- Public presentations, posters, videos and flyers

This section provides a plan of where the aforementioned material will be stored and how it will be accessed. The particularities of each dissemination category, with respect to storage and access, are highlighted in the subsections below. Regarding the appropriate licensing schemes for certain material (e.g., presentations), the project will consider the *Creative Commons licence "Attribution", CC(by)* (creativecommons.org).

2.1 Public deliverables

The public deliverables of symbIoTe document the progress of the work conducted by the consortium and provide all the necessary details to external parties to understand the symbIoTe work in depth. Deliverables are expected to be accessed by researchers and stakeholders in the IoT market interested on IoT interoperability, IoT platform/application developers. Also candidate applicants for the symbIoTe's Open Calls are potential recipients of symbIoTe deliverables.

The primary entry point for accessing the public deliverables is the symbIoTe's web site (www.symbiote-h2020.eu), from the respective section (*"Resources / Deliverables",* for more details, see Section 4.1 of D7.1 – Initial Dissemination Plans [1]). However, in order to make the deliverables discoverable in a wider scale (without having to visit symbIoTe's web site) all our deliverables are also stored in the Zenodo platform (www.zenodo.org), an open publishing platform for documents of any kind. This way, the deliverables are archived and preserved in a popular archiving platform, benefiting from the storage and backup functionality of Zenodo.

2.2 Scientific Papers

symbIoTe is aiming at publishing a number of high quality scientific papers, targeting the IoT research community as well as the IoT industry (for more details, see Section 4.6 of D7.1 [1]). Access to the published articles will follow a combination of the 'gold' and 'green' open access models. The 'gold' and 'green' (after the embargo period, if any) open access will be realized by the symbIoTe web site (www.symbiote-h2020.eu), from the respective section (*"Resources / Publications").* Additionally, pre-publication text is also made available through Zenodo, from symbIoTe's official account, but also from renowned research article repositories, like *ResearchGate* (www.researchgate.net) or *Acedemia* (www.academia.edu), from the authors personal accounts in those sites. This way, increased visibility of the papers will be achieved.

2.3 Technical reports

The symbIoTe consortium prepares technical reports, which document the progress of the project in a simple and brief but also practical way. Such reports are provided in the form of blog entries, in the technical blog section (*"Tech Blog")* of the symbIoTe's web site (www.symbiote-h2020.eu). It is envisioned that such blog entries are the entry points for interested readers to the works of symbIoTe. For more details on specific aspects, links to the respective deliverables (if available) are also provided. However, blog entries do not strictly follow the deliverables' schedule; they rather mark certain internal milestones, always with respect to the planned Open Calls and the information required to be available to applicants.

2.4 Public presentations, posters, videos and flyers

Apart from deliverables, scientific papers and technical blog entries, additional dissemination material is produced throughout the lifetime of the project for communication purposes. Such material includes public presentations in various events, posters, videos and flyers, all promoting the work done by symbIoTe. Such material, though indexed in the symbIoTe web site (www.symbiote-h2020.eu), from the respective section (*"Resources / Outreach material"*), it will be hosted in external platforms, for higher visibility. More specifically, flyers and posters are stored in scribd (www.scribd.com) and Zenodo, while public presentations are offered by symbIoTe's *Slideshare* (www.slideshare.net/symbiote-h2020) account. Videos on specific webinars, tutorials and marketing collaterals related to the project offerings are published on a YouTube channel dedicated to the project (https://www.youtube.com/channel/UClcqlb8yBKKBAmyiy1IadOQ), also referenced by the project website.

3 Source code

One of the main decisions of the symbIoTe project, is that the generated software and its source code will be available to the Open Source Community from the very beginning of the implementation phase. To this end, the entire source code is available from the symbIoTe's *GitHub* account (github.com/symbiote-h2020). The Open Source license of the source code is the Lesser GNU General Public License v3.0 (LGPL-3.0) for the Core Services and the BSD 3-Clause License (BSD-3) for the platform-side components. Finally, all required documentation for installation instructions, developers' guide, etc., are provided in *GitHub* and its respective wiki pages, as well in technical blog entries on the symbIoTe web site (see Section 2.3).

4 Pilot data

symbIoTe will showcase the innovations designed and implemented within the project through a number of small scale proof-of-concept pilots, following the identified Use Cases, as described in D1.3 [2]. These pilots will collect a number of data as specified in D9.2 [3], mainly related to sensor readings. The project will consider which of these data can be made available for open access, considering any sensitive information involved, and applying the appropriate curation approaches to remove such information. In this process, the respective procedures identified in D9.1 [4] will be considered and, in fact, the respective consent will have to be acquired before making the data publicly available. Hence, prior to the pilot phase of symbIoTe, the identification of the appropriate data will take place, followed by the acquisition of the informed consent and the ethical approvals. Finally, any sensitive information will be filtered out before being made publicly accessible. The main entry point for the symbIoTe open access data set will be the Zenodo platform (zenodo.org).

Besides the input data for the pilots, possible data generated by the pilots may also be considered for open access. At this point, the consortium starts planning the envisioned trials. Taking into more consideration the details involved for each trial, the following sections provide the description of the data to be collected per use case and how they will be treated by the consortium. The template provided in D8.1 [6] has been extended to include all the necessary details.

4.1 Smart Mobility and Ecological Urban Routing

UNIZG-FER – City of Zagreb	
Type of data	Volunteers will collect data regarding environment using the mobile sensor units. Data will include temperature, atmospheric pressure, humidity, pollutant gasses CO and NO2, noise level and GPS location of the measurement. Data will be exposed to end users through a corresponding smartphone application and in parallel will be sent to the OpenIoT instance running at UNIZG. Measurement frequency is once every 20 seconds, and data for transmission is encoded as collection of strings. Total volume of data can be measured in MBs but is directly correlated with the measured period.
Data collection (methods, standards used)	Data is collected on-the-fly while users are moving through urban areas. Anonymization of data is achieved by using virtual sensors which represent certain geographical areas (1 x 1 km cells) rather than exact identifier of user and its device that is performing measurements. So, there is no direct correlation between user device and stored measurement. Data will be stored in the OpenIoT instance running at UNIZG and its SPARQL end-point is available to use publicly but its access can be restricted by using firewall so that only data will be accessible by using the symbIoTe RAP component.
Documentation available	Data will be stored according to the OpenIoT ontology, which contains measurement value, unit of measurement and sensor unit metadata. Sensor unit metadata does not correspond to the physical sensors used in measurement campaign since data is anonymized and

	grouped by geographical locations using MGRS reference system.
Storage and backup	Data storage will be on the virtual machine running the OpenIoT instance; more precisely, it will be stored inside of the triplet storage Virtuoso OpenSource instance. Additional charging regarding storage, backup and management of data is not planned since the data will cover limited number of volunteers that will be active in the measurements campaigns covered by SMEUR use case. Data backup will be performed after each measurement campaign so that data is not lost in case of some incident. Additionally, data is stored on smartphone during the measurement campaign and can be used as backup. Data storage on the smartphone has primary use to recover measurements in cases of smartphone disconnections from the Internet.
Access and security	Data will be protected by the symbIoTe security mechanisms. Data will be accessible only by using RAP components which require user token in order to access data. Data set can be stored as publicly available so all symbIoTe users will have access to it or restricted only for user from certain platforms (e.g., platforms used in the SMEUR use case and SMEUR enabler). In addition to RAP data can be also obtained through Virtuoso SPARQL end-point, but that end-point will be accessible only from local machine. Data transfer during the measurement campaign will be encoded in the proprietary protocol used by the CUPUS middleware.
Ethical issues	All volunteers will give consent to collect, store and use data collected during measurement campaign, and the system will perform anonymization of used user device through mentioned virtual geographical cells. Other personal data (such as name, demographic data), except equipment id, is not stored or used throughout the SMEUR use case.
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	Primary use of data collected through measurement campaign will be in SMEUR enabler, to provide value-added services in urban environments to citizens that have applications that use SMEUR enabler. The data will be used to calculate most appropriate ecological route between two points in urban areas and to interpolate pollutant values in urban areas where do not exist sufficient number of measurements.
Data sharing (public, partners only, selected personal, etc.)	During the project data will be shared between project participants, namely SMEUR enabler and users of SMEUR enabler. Data users will be managed by UNIZG or symbIoTe consortium since all users will have to register to symbIoTe to be able to use SMEUR enabler.
Preservation (delete-after-	Data will be available after the project by using UNIZG instance of

project, archive, etc.)	symbIoTe.

AIT – City of Vienna	
Type of data	The data collected and managed in this trial include air quality data together with certain station metadata (location of station, name of station, "owner" of the station, geo-entity (city) of the station)
Data collection (methods, standards used)	For the collection of data, the approach is to make harvesting from publicly available sources. For Croatian (Zagreb) data this is from the URL: http://iszz.azo.hr/iskzl/rs/map/indeks. This is an unofficial URL as it is originally meant to provide data for an interactive map in form of JSON text. For Vienna data is pulled from their official API which is OGC/SOS compatible: http://luft.umweltbundesamt.at/inspire/sos?service=SOS&request=getCapabilities&version=2.0.0
Documentation available	Internal storage is in form of key/value pairs in an openUwedat specific format. Published data is in accordance with the symbiote best-Practise Information Modell (BIM). The published value is just a float value accompanied by information about unit of measurement.
Storage and backup	Storage in a local database within a VM dedicated to symbIoTe. Daily backup of the complete VM. This VM is hosted at AIT.
Access and security	Access to the data is only available through the symbiote interface (RAP). Data is marked as "publically available". This means it is readable by every client who has a security token from the core. In practice, this means that everybody who has an account in one of the registered platforms can read this data. Clients unrelated to the symbIoTe Core cannot access the data.
Ethical issues	No data related to any individual is stored. Data used is also available from other public sources.
IPRs (data ownership, licensing, etc.)	Data is available publicly available from the providers. A written (email) agreement to use the data within the project has been established.
Planned use (documentation, validation, analytics, etc.)	Proof the apps and algorithms with real world data
Data sharing (public,	Data is available "for all" through the symbIoTe RAP interface. This requires a valid symbIoTe account.

partners only, selected personal, etc.)	Using the data within the project for test purposes is not a problem. Commercial use or general public access is not an option without agreement of the original data owners. Data should not be copied and published from other servers. This does not refer to technical necessary stores to reduce access times (e.g. caching) and comparable techniques.
Preservation (delete-after-project, archive, etc.)	Data will be stored for as long as we need it for the project and post-project activities. After that it will be deleted.

UW – City of Porto	
Type of data	Air quality data obtained from air quality stations in the city of Porto. Depending on the sensors mounted on each station, the possible measurements are: • PM2.5 (µg/m3 - Particulate Matter < 2.5µm diameter) • PM10 (µg/m3 - Particulate Matter < 10µm diameter) • O3 (µg/m3 - Ozone) • NO2 (µg/m3 - Nitrogen Dioxide) • OX (µg/m3 - Oxidizing Agents) • CO (µg/m3 - Carbon Monoxide) • CO2 (µg/m3 - Carbon Dioxide) • T.Air (°C - Air Temperature) • RH.Air (% - Relative Humidity) • P.Air (hPa - Air Pressure) • W.Sp (Wind Speed) • W.Dir (° - Wind Direction) • UV.Rad (Ultraviolet Index) • Sol.Rad (W/m2 - Solar Radiation) • Noise (dB(A) - Sound Level)
Data collection (methods, standards used)	Data from the stations is communicated through a gateway through HTTPS, and it already comes in the FIWARE data model format.
Documentation available	The data will be formatted, stored and offered to follow FIWARE's harmonized data models[1].

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[1] https://www.fiware.org/developers/data-models/

Storage and backup	Data is stored at Ubiwhere's servers, with a daily backup stored in a cloud service.
Access and security	Public access to the data will be done through the symbIoTe platform.
Ethical issues	The data is public, so no ethical issues to consider.
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	The data will be used to compute the air quality index of the roads of a given city. This will later be used to compute green routes for the users of the application developed within the use case.
Data sharing (public, partners only, selected personal, etc.)	The data will be shared publicly through symbIoTe.
Preservation (delete-after-project, archive, etc.)	The data will be available after the project through symbIoTe.

4.2 Smart Residence

AIT – Ambient Assisted Living (AAL) scenario	
Type of data	Float/Text (Body weight measurements, personal wellbeing as free-text input, heart rate, daily steps taken).
Data collection (methods, standards used)	BLE-enabled body scale, BLE-enabled fitness tracker; recording of personal wellbeing through symbIoTe Smart Mirror app; Google Fit access for daily step counts
Documentation available	KIOLA uses a proprietary data format based on Health Level 7 (HL7) data models. Public documentation is not available.
Storage and backup	Data is stored within the KIOLA database and locally within the Smart Mirror app; backup of the KIOLA database is performed daily.
Access and security	symbiote authentication & authorization methods; OAuth2 Workflow for Google Fit Access (Daily Steps Taken)
Ethical issues	During the evaluation trials people are asked to sign an informed consent ensuring that data collection can be used in de-identified form for research and publications.
IPRs (data ownership,	None

licensing, etc.)	
Planned use (documentation, validation, analytics, etc.)	Validation of a real use case and integration with symbIoTe
Data sharing (public, partners only, selected personal, etc.)	Partners only
Preservation (delete-after-project, archive, etc.)	Archive

NXW – Dynamic Interface adaptation, energy saving scenario	
Type of data	Values (integer, float) from Lamps, light dimmers, RGB lights, temperature sensors, environmental sensors (temperature, humidity), weather station
Data collection (methods, standards used)	Standards for data collection are platform specific (KNX, ModBus) and symbIoTe offers common interfaces (OData, REST) to access to the data.
Documentation available	symbIoTe BIM to describe the data format; the data format used inside the platform is proprietary
Storage and backup	Data is stored in Symphony internal storage for debug purposes; they can be retrieved through symbIoTe, which does not store any data or make any backup.
Access and security	symbiote ABAC authentication & authorization methods
Ethical issues	None
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	For the trial demonstration
Data sharing (public, partners only, selected	Partners only

personal, etc.)	
Preservation (delete-after-project, archive, etc.)	Delete-after-project

S&C – Indoor air quality scenario	
Type of data	Four houses and one in Barcelona are used to get information about indoor air quality. Data include temperature, humidity, luminosity, motion, CO2, smart plug with energy monitoring) as float values and identification and GPS location of the installation. In addition, outdoor air quality data measured by outdoor stations placed at representative spots of the city. These data include particulate matter (PM10) and gaseous pollutants: nitrogen dioxide (NO2), ozone (O3), sulphur dioxide (SO2), and carbon monoxide (CO).
Data collection (methods, standards used)	Z-Wave standard. Data collection every 15 minutes for temperature (the reporting happens before that time frame when the temperature changes +/- 1 degrees), humidity, luminosity, CO2, and a trigger for motion and smart plug.
Documentation available	Following the data forma described in symbIoTe BIM. nAssist's format: https://github.com/Sensing-Control-DevTeam
Storage and backup	Data are stored in a local database. Daily backup will be carried out
Access and security	Access and security will be done through symbIoTe ABAC authentication & authorization methods
Ethical issues	A Participant Information and Consent Form (PICF) will inform participants about the project and explain the tests involved. The user will consent to the treatment of personal data expressed by the PICF. The confidentiality of data provided by users and its treatment is guaranteed in accordance with current legislation on the protection of personal data (Constitutional Law 15/1999, of 13 December, for the protection of personal data).
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	Primary use of data collected is the validation of real use cases through the integration with symbIoTe
Data sharing (public, partners only, selected	During the project, data will be shared with symbIoTe participants.

personal, etc.)	
Preservation (delete-after-project, archive, etc.)	Delete-after-project

4.3 Smart Campus

IOSB – Karlsruhe Institute of Technology campus	
Type of data	Symbolic (Room Identification)
Data collection (methods, standards used)	Bluetooth Low Energy Beacons readings from Smartphones
Documentation available	Two application specific Models for IOSB and KIT
Storage and backup	Stored in SensorThingsServer. Daily backup.
Access and security	symbIoTe ABAC authentication & authorization methods
Ethical issues	None (location of persons is not recorded)
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	Validation of a real use case and integration with symbIoTe
Data sharing (public, partners only, selected personal, etc.)	Campus owners and trial participants only
Preservation (delete-after-project, archive, etc.)	Delete-after-project

4.4 Smart Stadium

ATOS – Atlètic Terrassa Hockey Club	
Type of data	Data involved:

	• the Visitor device (anonymized id & location)
	• the Retailer device (anonymized id & location)
	• the Promowall device (id & location)
	• the Shop list with the Product catalog, prices and offers.
	• the Product data (id, description and images)
	• the Orders (products, quantities; for the use case, order processing does not include payment)
	None of these are private / confidential data
Data collection (methods, standards used)	Apps in mobile devices, detecting location beacons (BLE).
Documentation available	symbloTe BIM to describe the data format for the entities registered in SymbloTe core.
Storage and backup	The application data, stored in the Smart Stadium server, is maintained in a MongoDB database and includes an extended Device registration, the Shops, Catalog, Products and Orders. Backup is done on demand.
Access and security	symbloTe authentication & authorization methods
Ethical issues	None
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation, analytics, etc.)	Validation of a real use case and integration with symbloTe
Data sharing (public, partners only, selected personal, etc.)	Partners only
Preservation (delete-after-project, archive, etc.)	Delete-after-project

4.5 Smart Yachting

NAVIGO – Viareggio marina and Marina Cala De' Medici (Tuscany, Italy)	
Type of data	Yacht Data (Maintenance and Consumable needs – expressed by the Schema.org categories of the potential suppliers – Latest routes, Port and Starboard exhaust temperature, Average fuel consumption, Tank level – in liters – for several tanks – Fresh, Grey and Black water tanks, Service Fuel and Storage fuel tanks) and Port Data (presence sensors installed in piers).
Data collection (methods, standards used)	Through symbIoTe common interfaces (OData, REST) data is fetched from the Yacht (seen as a Roaming Smart Device) and the port's IoT Platform (connected to a Smart Space). LoRaWAN is used to detect when the Yacht is approaching (before it has entered the Port and steadily connected via Wi-Fi): how to detect and manage this phase is still under investigation in WP4.
Documentation available	symbIoTe Smart Yachting BIM describes the use case data format. The IoT platforms involved in the use case – Symphony and Navigo Digitale IoT – have proprietary data format. In particular, the latter is a platform used until now for internal use in Navigo project and no public documentation is available.
Storage and backup	Data is stored in the Yacht IoT Platform (and made accessible via symbIoTe's standard interfaces), but only for caching purposes. No historical data is maintained in the Yacht. The two use cases applications on the other hand (Centrale Acquisti for the Automated Supply Chain showcase and Portnet for Smart Mooring) will store all data fetched from Yachts. Data from LoRaWAN detection phase and presence sensors installed in the piers will not be stored (they are only used to trigger some actions in Smart Mooring).
Access and security	symbIoTe ABAC authentication & authorization methods
Ethical issues	None. No personal data will be specifically acquired for the Smart Yachting trial. The two main showcases will collect machine data, taken from sensors on board of the yachts.
	Information about users or their ownership (e.g. the Yacht) is not directly managed or stored in the symbIoTe enablers developed for the project: it is instead managed by the two existing Navigo applications – Portnet and Centrale Acquisti – that will be integrated in the trials, whose compliance with privacy laws (e.g. GDPR) is beyond the scope of symbIoTe.
IPRs (data ownership, licensing, etc.)	None
Planned use (documentation, validation,	For the trial demonstration

analytics, etc.)	
Data sharing (public, partners only, selected personal, etc.)	Partners only
Preservation (delete-after-project, archive, etc.)	Delete-after-project

5 Conclusions and Next Steps

This deliverable provides the final Data Management Plan of symbIoTe. Three categories of data that can be offered as open access have been identified; namely, the dissemination material, the software source code and the pilot/trial data. For these categories, the respective platforms that will host the data have been identified.

Regarding the pilot/trial data, since symbIoTe focuses on the interconnection of IoT platforms and does not offer yet another IoT platform, it is expected that not all data stemming from the interconnected platforms will be accessed by the symbIoTe middleware. However, all possible sensing data have been identified and it remains to be checked prior to the conduction of the trials, which kind of data can support the evaluation of the symbIoTe offerings, so as to be made publicly available.

6 References

[1] symbIoTe project Deliverable D7.1 – Initial Dissemination Plans; June 2016.

[2] symbIoTe project Deliverable D1.3 – Final Specification of Use Cases and Initial Report on Business Models; December 2016.

[3] symbIoTe project Deliverable D9.2 – POPD Requirement No.1; February 2016.

[4] symbIoTe project Deliverable D9.1 – POPD Requirement No.2; February 2016.

[5] European Commission, Directorate-General for Research & Innovation, Guidelines on Data Management in Horizon 2020, version 2.1; 15 February 2016.

[6] symbIoTe project Deliverable D8.1 – Initial Data Management Plan; June 2016.

7 Abbreviations

CC	Creative Commons
EUPL	European Union Public Licence
GNU	GNU's Not Unix!
GPL	General Public License
IoT	Internet of Things
POPD	Protection of Personal Data