
SYNCHRONICITY

OPEN CALL

SYNCHRONICITY FRAMEWORK



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CHANGELOG

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1. Introduction

SynchroniCity aims to foster the development of a global Internet of Things (IoT) market where cities and businesses develop shared digital services to improve the lives of citizens and grow local economies.

Cities in Europe and around the globe develop at a different pace with respect to implementing, distributing and managing IoT-enabled services for their citizens. This spectrum ranges from those cities that have not yet embedded any IoT digital architecture to others that are making use of advanced features of their IoT architectures to deliver enhanced smart city services. Cities have therefore their own and distinct IoT architecture, with their own specific components that are adopted to the needs of the city and the reality of its context.

The SynchroniCity project has designed and created the SynchroniCity architectural framework having in mind the inclusion of this diversity. At the core is the Minimal Interoperability Mechanisms (MIMs) of the Open & Agile Smart Cities ([OASC](http://oascities.org))¹ network with over 100 cities in 24 countries.

The SynchroniCity framework is not aiming at imposing a new platform or even architecture for cities to enable the realisation of a global market but instead is proposing a more flexible approach where only key interoperability points and mechanisms, based on standard interfaces, are identified for cities to adopt whilst maintaining their local preferences, in terms of architecture and suppliers. Built around OASC MIMs, this engenders the common technical ground required for a global market for IoT-enabled services for cities and communities. We believe that only using this open and adaptable methodology a common market can become a reality.

We think that creating a simplified, open and agile digital market across borders will help cities and its citizens to get better services. It will also help businesses of all sizes to transparently compete and easily scale their products and solutions. This common technical foundation will enable the identification and development of smart city standards that will allow to establish an effective data marketplace for all, where data will be transparently traded in a distributed manner.

¹ <http://oascities.org/about-oasc/>.

2. The SynchroniCity Architecture

Built on the neutral branding of OASC, with the minimal interoperability mechanisms for standards-based innovation and procurement, the high-level reference architecture model for IoT-enabled smart cities that SynchroniCity has defined provides a set of logical components and functionalities that can enable different cities to be actively part of a global market for IoT-enabled urban services.

The SynchroniCity reference architecture is the result of a thorough analysis of different cities and their city platforms as well as current IoT enablers and standards, and can be categorised by the following aspects:

- **Existing infrastructures and use case requirements in cities** drove the definition of the functions and components of the architecture. The SynchroniCity reference architecture recalls a layered approach used to categorise the technical infrastructure of cities stressing the aspects of southbound integration (IoT infrastructure), context management (to interconnect between applications and allow for workflow efficiency), security and privacy and northbound API (IoT-based services and the corresponding applications). These main layers, further extended in the global reference architecture picture, can be considered the central pillars of all the cities IoT architectures and for this reason, are directly reflected in the SynchroniCity one.
- **Reuse of standards and existent approaches:** SynchroniCity logical components try to cover the common functionalities identified in the most relevant smart city architectures, maintaining a very generic approach that will allow cities to implement the architectural blocks in different ways reusing standard approaches.
- **Open & Agile Smart Cities² (OASC) principles:** the architecture has been designed following the OASC principles:
 - a common standard API for **context information management:** the context data manager is a key component of the SynchroniCity architecture

² <http://oascities.org/>

and the implementation of its NGSI API and the emerging NGSI-LD API is considered an “interoperability mechanism” to enable cities to participate to the SynchroniCity framework.

- a common set of information models: semantic interoperability achieved through the adoption of **common data models** is introduced as a basic requirement to enable re-use of the data for building applications in different cities and domains.
- a set of common standards data publication platforms: the role of data is crucial in SynchroniCity and for this reason, the reference architecture includes **specific data management components** that aim to provide, through standard interfaces, all the functionalities related to data lifecycle management.

The following picture depicts a high-level overview of the Synchronicity architecture and highlights the interoperability points and mechanisms (in red) that SMEs and large business applying for the open call will need to link to in order to integrate their solutions into the SynchroniCity framework. These connecting components are also the ones that new city applicants will need to incorporate during the pilot phase if they are successful in the open call.

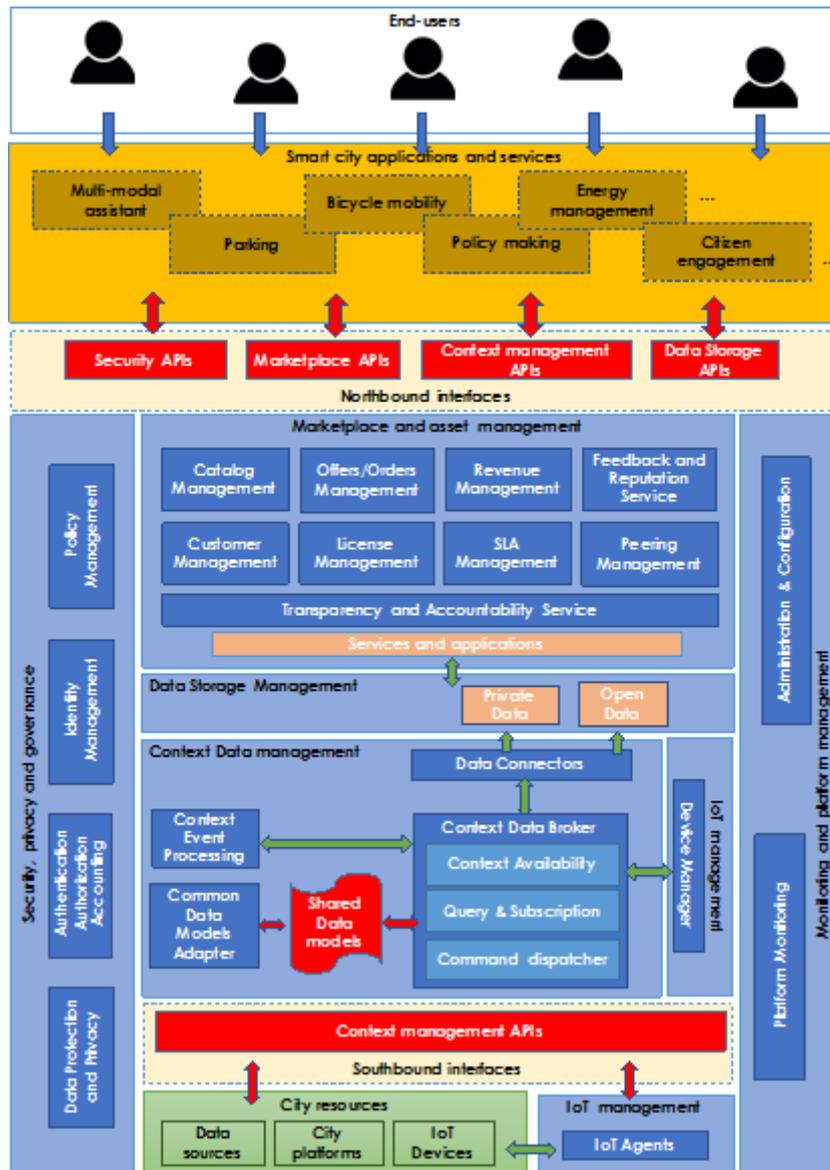


Figure 1: SynchroniCity reference architecture with identified interoperability points and mechanisms.

- **City IoT resources and data** represent some of the assets that are provided by the city: these can include IoT devices, historical and open data, existent proprietary platforms and data provided by citizens.
- **Southbound interfaces (infrastructure) & connectors:** in order to provide a uniform and standard access to manage city resources, SynchroniCity provides a **Southbound API** that, in conjunction with standard or custom connectors (e.g. protocols adapter) allows to enable interoperability among different technologies and the SynchroniCity framework. This represents one of the relevant "interoperability

points” that should be implemented by cities to be part of the SynchroniCity ecosystem.

- **IoT Management** is the component responsible to interact with the devices that use different standards or protocols making them compatible and available to the SynchroniCity architecture; through its interface this component provides to the Context Management the data coming from Southbound Interfaces layer, handling the creation and the updates of Context Entities and their attributes.
- **Context Data Management:** it is the core of SynchroniCity architecture and it manages the context information coming from IoT devices and other public and private data sources, providing a uniform approach and interface. Context information contains last updates on status information about real world entities defined in a structured way.
- **Data Storage Management** provides functionalities related to the data storage and historical access in the specific context of IoT systems and smart city architecture interacting with heterogeneous sources.
- **IoT Data Marketplace** supports business interactions between data suppliers, that are part of the SynchroniCity ecosystem, and consumers. It will implement a hub to enable digital data exchange for urban data and IoT capabilities providing features in order to manage asset catalogues, orders, revenue management. The IoT data marketplace is further described in Section 3.
- **Security:** this module covers all the security aspects related to three main pillars: data, IoT infrastructure and the framework services, which underpin the applications and services of the cities. Around these pillars, security functionalities provide crucial security properties such as confidentiality, authentication, authorisation, integrity, non-repudiation, access control, etc.
- **Northbound interfaces (applications):** is the set of APIs that provides access to all the platform functionalities (context information, historical data, security features, IoT data marketplace) that will be used by upper services and smart city end-user applications. This layer can be considered an interoperability point because it is the

main way, for SynchroniCity baseline services and external applications, to interact with the architecture and to be part of the digital single market enabled by SynchroniCity. In the upper part of the architecture are shown the end-users smart city applications and services that will rely on the SynchroniCity functionalities and data: in particular, using the same API and data models, the services will be able to work and interact with the different cities, part of SynchroniCity ecosystem, with minimum customisation, simplifying the replications process.

3. The SynchroniCity IoT Data Marketplace and IoT Product Marketplace

Cities have the opportunity to become catalysers for a multitude of data originating from smart devices connected to a gathering infrastructure. Data owners range from businesses that have information that is valuable to local authorities, to citizens or volunteer groups that have information that is valuable to businesses.

IoT data marketplace provides a means of unlocking existing IoT data silos and offer opportunities for generating new revenue streams and new value for all parties. The SynchroniCity vision is to scale these opportunities by envisioning a vibrant IoT data marketplace as a crucial component of the SynchroniCity architecture and a key enabler for the creation of a global market for IoT-enabled urban services with clear licensing agreements, standardised interfaces and common information models. This vision is also shared with the OASC community, which already now encompasses more than 100 cities across the world.

By having an IoT data marketplace, application developers could obtain access to open data from a multitude of sensors and/or actuators made available by assets owners (data providers) to build new applications, thus enabling the creation of new smart city services. It is important noting that application developers will not have access to the sensors and actuators. These will remain in control of the infrastructure owner or IoT service provider. On the other hand, data providers could be incentivised to deploy IoT infrastructures having the opportunity to generate revenue by selling their data on the market, which every user could benefit from. Marketplace providers could benefit from running such a framework by attracting new customers (e.g. data consumers and data providers) and making a profit out of marketplace

transactions. Cities fostering the creation of new smart services could attract useful data providers and increase their return on investment through infrastructure reuse.

The **SynchroniCity IoT Data Marketplace** is the result of a thorough analysis which revealed a set of characteristics that are essential for the successful adoption of an IoT data marketplace. These critical functionalities are being adopted by the 8 core pilot cities (Antwerp, Carouge, Eindhoven, Helsinki, Manchester, Milan, Porto, and Santander) and will be available for the open call applicants. You can find the current status of the adoption of these features by the core pilot cities on our [website](#)³.

These features are the following:

1. **Data catalogue with lookup functions.** Data providers expose their data source offerings in a catalogue, which data consumers can navigate and lookup for specific offerings.
2. **Access control.** Cities are able to decide how to regulate the access to the framework - either by vetting registration requests from both data providers and data consumers or by allowing an open access.
3. **Tools to create license agreements.** Data providers can associate license agreements with their offerings. Agreements include both commercial and open licenses. Furthermore, to better match the expectations of the stakeholders, data providers can fill in license templates with variable content, configurable based on several terms: (i) exclusivity of the data license; (ii) business sectors which the data may be used for; (iii) geographical restrictions for the usage of data (iv) period of validity of the authorisation/right to access data; (v) intended purpose that the data is used for; (vi) authorisation to resell data.
4. **Seamless monetisation of transactions.** The IoT data marketplace currently offers PayPal as a payment method and also supports revenue sharing when transactions involve multiple stakeholders (e.g. data offering owned by multiple parties). Furthermore, the marketplace provider receives a fee for each transaction as an incentive to run the framework.

You can access SynchroniCity IoT data marketplace [here](#)⁴.

³ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

⁴ <http://iot-data-marketplace.synchronicity-iot.eu>

Beyond the open call, we plan to expand the current version of the marketplace with advanced features that allow to define and monitor Service-Level Agreements (SLAs) related to the IoT data purchased through the marketplace as well as to assess the quality and trustworthiness of IoT data and its providers.

Some of the core pilot cities will be adopting the full version even during the open call piloting phase. For updated information on the implementation of SynchroniCity architecture, you need to visit our website [here](#)⁵.

We define the basic marketplace modules as a common set of APIs. Specifically, we have built on top of the FIWARE/TMForum Business API Ecosystem and expanded their reference implementation to suit our requirements.

The high-level view of the data marketplace component is shown in Figure 2 and consists of the following modules:

- **Marketplace API.** The core element of the framework and includes several sub-components that expose a set of functions to interact with that. Specifically, the Marketplace API allows data providers to register or import data sources into the framework, and publish offerings containing its description (e.g. version, data model, endpoint URL), and allows data consumers (e.g. service developers) to discover and purchase offerings.
- **Marketplace portal.** An optional module, providing a user interface through which data providers and data consumers can interact with the framework, use the marketplace API, and manage their accounts and information.
- **Security.** It includes three sub-modules: (i) *Identity management* system to store and organise the identities of users; (ii) *Authentication* module to regulate the accesses to the framework; (iii) *Authorisation* module to grant the access to the functionalities and digital assets according to predefined policies.

⁵ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

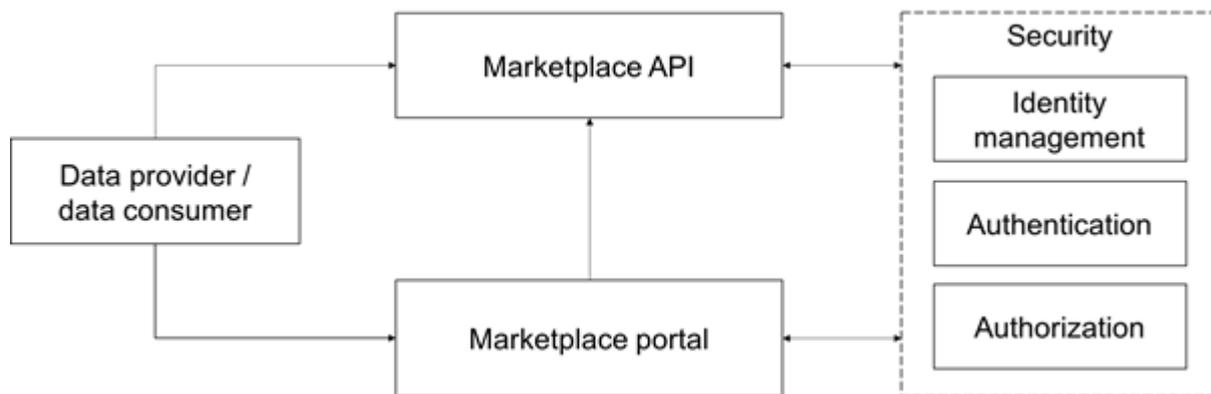


Figure 2: High-level view of the IoT data marketplace framework.

Apart from the IoT data marketplace (“Northbound”) which is supported by specific functionality and APIs, SynchroniCity also considers the IoT product market place for IoT devices and solutions (“Southbound”) which is highly relevant to fostering a thriving market for IoT-enabled urban services. It is focusing on developing a marketplace for IoT products interoperable with the SynchroniCity framework, providing interested cities for references to find SynchroniCity compliant IoT devices and solutions and help to foster IoT ecosystem.

The Southbound IoT product marketplace can help to find the IoT devices and solutions that are already deployed in SynchroniCity open call core pilot cities in diverse urban services.

4. SynchroniCity and the Smart City Standards

SynchroniCity has a strong focus on standards – existing and emerging – and is aiming at influencing the political and industrial spheres at European and global levels and propose recommendations for cross-domain standards-based innovation and procurement relating to the IoT LSP open calls.

This work will be the result of a joint effort amongst the LSPs (IoF2020, SynchroniCity, ActivAge, MONICA, AutoPilot).

Cross-domain interoperability is recognised as a fundamental barrier to achieving large-scale for IoT-enabled services in Europe as well as globally (e.g. ETSI STF 505). One of the identified paths forward is to separate a full architecture reference model on one hand, and on the other

hand interoperability points and mechanisms, based on emerging specifications and standards.

The standardisation activities linked to SynchroniCity are connected to the OASC Minimal Interoperability Mechanisms. The harmonisation of the heterogeneous smart city market through interoperable common set of IoT related enablers and services will pave the way towards a global adoption of European technologies and standards, in line with the "2016 Rolling Plan on ICT Standardisation" and its follow-up 2017 version established by the Digital Single Market initiative launched by the EC.⁶

Through the open call pilot projects, SynchroniCity will be contributing to relevant standardisation processes and Standards Developing Organisations in connection with ETSI ISG CIM (European Telecommunications Standards Institute Industry Specification Group on Context Information Management) and the ITU-T (International Telecommunication Union-Telecommunication Standardization Sector).

During the pilot phase, the successful open call applicants will be required to provide feedback through bi-monthly reports on the usability of specific elements of the proposed standards, like those referring to data collection, data management, and more specifically to APIs (e.g. ETSI OneM2M r2 and ETSI ISG CIM NGSI-LD API).

Currently, our SynchroniCity teams are working on a preliminary version of the "Context Information Management API Specification" that allows users to provide, consume and subscribe to context information in multiple scenarios and involving multiple stakeholders.

The particularities of the requested information are going to be made available to the successful open call applicants at the time they receive the Pilot Handbook.

⁶ http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=14510.

5. What do I need to know about the SynchroniCity Core Pilot Cities?

5.1 What are the minimum architecture components that the Core Pilot Cities will implement for the Open Call?

The minimum number of components and interoperability mechanisms that the core pilot cities will adopt for the open call are:

- A set of APIs to interact with the SynchroniCity architecture through northbound (IoT applications) and southbound (IoT infrastructure) interfaces. This is based on the [NGSI API standard](#)⁷ and the [preliminary ETSI NGSI-LD API \(GS CIM 004\)](#)⁸.
- A set of APIs to interact with the SynchroniCity IoT Data Marketplace
- An OAuth2.0 interface to access security features

These components will also need to be adopted by the new city applicants during the piloting phase if their project is selected. More information about new city applicants on how to adopt these components can be found in Section 7.

The basic set of APIs to interact with the SynchroniCity architecture and IoT data marketplace are the following:

⁷ <http://fiware.github.io/context.Orion/api/v2/stable/>

⁸ <http://www.etsi.org/news-events/news/1300-2018-04-news-etsi-isg-cim-group-releases-first-specification-for-context-exchange-in-smart-cities>

Table 1: Interoperability mechanisms of SynchroniCity framework.

Interoperability Point	Description	Specification document (synchronicity-iot.eu/about)	Related Standards [and Baselines]
Context Management API	This API allow to access to real-time context information from the different cities.	Reference Architecture for IoT Enabled Smart Cities (D2.10)	ETSI NGSI-LD prelim API, OMA NGSI, ITU-T SG20*/FG-DPM*
Shared data models	Guidelines and catalogue of common data models in different verticals to enable interoperability for applications and systems among different cities	Guidelines for the definition of OASC Shared Data Models (D2.2) Catalogue of OASC Shared Data Models for Smart City domains (D2.3)	[SynchroniCity RZ + partner data models]
Marketplace API	It exposes functionalities such as catalog management, ordering management, revenue management, SLA, license management etc.	Basic Data Marketplace Enablers (D2.4) Guidelines for the integration of IoT devices in OASC compliant platforms (D2.6)	[TM Forum API]
Security API	API to register and authenticate user and applications in order to access to the SynchroniCity-enabled services.	Reference Architecture for IoT Enabled Smart Cities (D2.10)	OAuth2
Data Storage API	This API allows to access to historical data and open data of the reference zones.	Reference Architecture for IoT Enabled Smart Cities (D2.10)	ETSI NGSI-LD, DCAT-AP [CKAN]

Note that the core pilot cities are currently adopting the SynchroniCity architecture and its IoT data marketplace. To understand at which stage of their implementation they are during the open call you can visit our [website](#)⁹.

5.2 What datasets are available in each Core Pilot City?

The following [table](#)¹⁰ shows a list of datasets from the different core pilot cities that are available for the open call and can be accessed through the SynchroniCity API. For each dataset is also indicated the specific data model used to describe content, the associated license/s and a price plan if applicable.

The datasets may have open access or restricted access, depending on each city and its context. It will be the responsibility of the open call applicant to ensure these elements are considered in the proposal.

⁹ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

¹⁰ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

This information is live as many core pilot cities are currently unlocking the provision of some of the datasets. Please, refer to our [website](#)¹¹ for the latest updates.

5.3 Information about the Core Pilot Cities

For the purpose of the open call and in order to have an overall understanding of the eight core pilot cities, we have developed eight individual city cards for each city that can be found in Annex 1.

With these cards, you will be able to quickly gather information on what are the values of each core pilot city; what are their priorities; the themes and challenges they are interested in; and what data and assets they have available through the SynchroniCity framework. In addition to understanding what is common to the different cities, you will be able to identify other data and assets of the individual cities that could be interesting to consider for the open call application to enhance your project and bring context to the solution you propose. This material could help you decide on the core cities you would like to pilot your IoT-enabled solution in.

Because of the complex reality of the smart city market, SynchroniCity will facilitate a Bonding & Customisation Workshop in London at the beginning of February 2019 for the winning applicants where aspects like contextualisation of the pilot solutions will be discussed between the pilot cities and the winning applicants. More information on the event will be available on our [website](#)¹².

Furthermore, you can find other general information on the core pilot cities on our [website](#)¹³.

6. I am an SME or large business; how do I handle all this information to apply for the open call?

¹¹ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

¹² <http://synchronicity-iot.eu/events>

¹³ <http://synchronicity-iot.eu/cities>

In this document, we have presented a wealth of information around the SynchroniCity framework that you need to consider when applying for the open call. While getting familiar with the technical and city environment of SynchroniCity is the responsibility of the applicant, we would like to help you in the process. As a result, we have compiled some suggestions that you may want to take into account during the open call process.

1. Have a good understanding of the solution you would like to propose and identify in which open call challenge fits best.
2. Check the table of *Themes & Challenges by Cities* in the *Guide for SME and Large Business Applicants* to see which cities are interested in piloting the challenge you have chosen. You can incorporate new cities through your Pilot Group if you wish but it is your responsibility to build this relationship.
3. Read the pertinent *City Cards* and get an overview of the datasets and assets available in each city. Get also a feeling of what are the values of these cities.
4. Check our [website](#)¹⁴ for the latest updates on the city data and assets available in the relevant cities through the SynchroniCity architecture. You will need to make use of some of these data and assets for the open call unless you provide your own data. In the latter case, you will need to make your data SynchroniCity compliant.
5. Check on our [website](#)¹⁵ the readiness level of each relevant city with respect to the SynchroniCity architecture. This will allow you to know which components of the architecture each city has implemented and has them available for the open call. While all cities need to have implemented the minimum requirements of the SynchroniCity architecture, some may have adopted other SynchroniCity advanced features that you may want to make use of. You will need to check this website on a regular basis for updates on the readiness level of the cities.
6. Based on all previous steps, you should be able to have enough information to build your project proposal from a technical point of view. The solution you propose should be tested in at least 3 cities simultaneously.
7. In addition to the previous steps, you may opt to enhance your solution by making it relevant to the context of each city. For this, you can check again the *City Cards* to

¹⁴ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

¹⁵ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

understand what other data and assets are available in each relevant city, which you could include in your proposal. If you make use of this additional data, you will be responsible for making it SynchroniCity compliant. This is an activity that can be part of your proposal.

7. I am a city; how should I adopt the interoperability points and mechanisms of the SynchroniCity architecture?

If the proposal of your Pilot Group is successful you will be expected to adopt the minimum required components of the SynchroniCity architecture during the piloting phase of the project. This is because the solution that your Pilot Group will demonstrate in the selected open call pilot cities (including yours) needs to be integrated into the SynchroniCity framework to prove the viability of this digital single market. You can find the list and description of these components in Section 5 of this document.

The precise steps you will need to follow to integrate these components are the following:

1. **Identify your City Assets.** Cities should select which components of the existing city infrastructure, have to be connected with the SynchroniCity framework. It is necessary to identify which datasets should be exposed following the Synchronicity specifications: these datasets can include, for instance, IoT real-time data, historical data and open data.
2. **Implement SynchroniCity API.** It will be necessary to be compliant with the SynchroniCity API. The API can be implemented progressively, in different steps, depending on the technical infrastructure of your city. Security and the Context Management APIs are the basic ones. SynchroniCity project provides existing software components to simplify and speed up this phase.
3. **Harmonise Data Models.** In order to be part of the SynchroniCity ecosystem, all cities need to provide a common semantic level using the same data models. SynchroniCity defines and reuses a set of standard data models for different smart city domains. A new city should adapt its own data models to the SynchroniCity ones: this

phase is also supported by the SynchroniCity project through guidelines and dedicated tools (see [link](#)¹⁶).

4. **Be part of the SynchroniCity Marketplace.** SynchroniCity has the aim of creating an IoT-enabled smart city digital single market. In order to achieve this objective SynchroniCity provides a common marketplace for IoT data and IoT products in which city data can be offered to different stakeholders through specific business models, with or without monetisation models.

The SynchroniCity project partners will be able to provide you with general support guidelines for the adoption of the SynchroniCity architecture, but it is important to notice that these will not provide technical support on-the-ground to the new cities. It is therefore recommendable that, if you do not have technical resources in your city, you have links with a technical organisation that can locally support the integration of the architecture.

¹⁶ <https://synchronicity-iot.eu/data-tools-services-in-core-pilot-cities/>.

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