SMART CITY ECOSYSTEM:
Laying the foundations - using decision-making sovereignty

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Introduction

One thing has become abundantly clear in the current crisis, only those who initiated digitization swiftly at an early stage have been able to benefit from their decision and react more flexibly and quickly to the dramatic changes. The crisis has therefore not halted the adoption of the concept of the intelligent city (“smart city”), but rather accelerated it. The Smart City is already being lived today in a variety of ways. In the future, however, it will have an even greater impact on work processes and the living conditions of citizens. Whilst offering new opportunities, bringing digitization directly to the individual citizen would also appear to increase the risk for cities and the public sector through having to hand over the design and regulatory authority to IT service providers. There is usually a gap between the digital vision and the implemented Smart City processes: how do the regulations, according to which the processes are automated and controlled, get into process control?

How can a city design and expand its decision-making authority for its digital future?

For controllability, it is important to ensure that the path between the functional control requirements and the technical implementation is uninterrupted. With the use of universally definable Digital Twins based on the international standard NGSI-LD (hereafter referred to as “Digital Twins”), the authors of the “Smart City Ecosystem” initiative support the option of adapting these Digital Twins to the control requirements of the city. Technologically, the initiative is based on the so-called system-of-systems approach, which describes the interaction of different platforms and systems in an ecosystem. Most municipalities have already invested in domain-specific platforms that need to be integrated into such an ecosystem. This may be augmented by the addition of geoinformation systems and business management platforms such as those from SAP. Following the idea of common standards within an ecosystem, process definition will in future address the Digital Twin instead of the specific providing system.

FIWARE, as the leading open source platform technology, in cooperation with **NEC** (as a FIWARE Platinum Partner) and **SAP** (as a leading software provider for business processes), has laid the common foundation for the technical realization of the ecosystem with this initiative.

In order to faciliate this move towards encapsulating the technical control of processes within the procedures in the administration, the initiative also includes the consulting firm **Unity** and the implementation specialist **itelligence**. As a specialist in public administration, Unity can implement

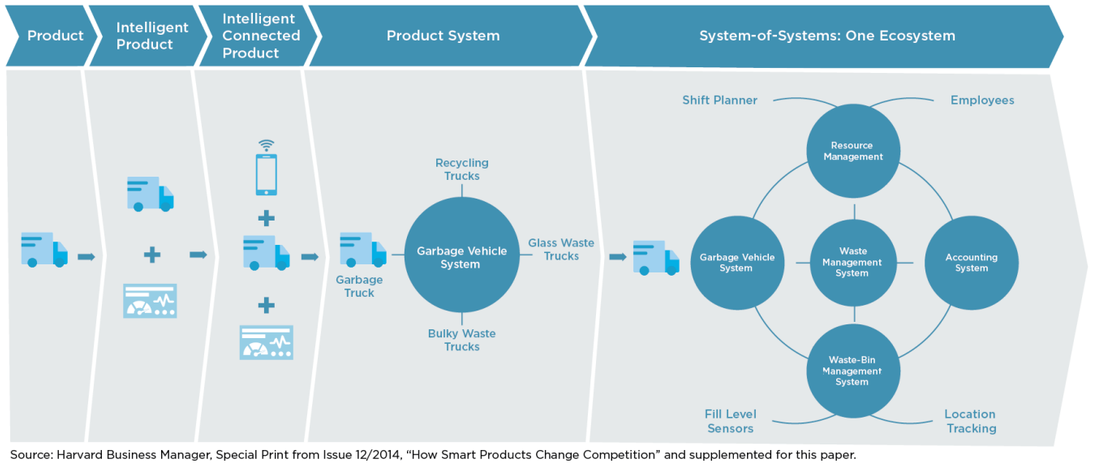
the optimization of processes effectively, and enable cities to consistently operationalize control requirements and political framework conditions down to the level of individual technical processes. itelligence supports the implementation with its experience from the worldwide support of IT projects in the public sector.

As for the technical implementation, municipalities can also rely on an experienced team of technical assets, such as the FIWARE Context Broker and IoT services on the SAP Cloud Platform.

The ecosystem enables access to smart technical data (e.g. a sensor phalanx in an IoT environment) together with the data that cities already have in their own systems, or even extending to classic control systems. This means that cities do not have to collect or integrate large amounts of data. Rather, the combined expertise of SAP and FIWARE, the two leading global providers of ERP & Analytics systems and Smart City data processing, enables the orderly use of data throughout the process. Communications within the solution are based on the recognized ETSI standard “Context Information Management (ETSI ISG CIM)”, and are processed via the Context Broker, a platform recommended and supported by the European Union (Connecting Europe Facility, CEF).

In this way, municipalities are able to incrementally lay down the necessary data foundations for the future. The shaping of digital life in the city and thus also the decision-making authority remains in the hands of the municipality.

The Concept: Realization of the Smart City Ecosystem with a System-of-System



Source: Harvard Business Manager, Special Print from Issue 12/2014, "How Smart Products Change Competition" and supplemented for this paper.

The underlying architecture is based around a "System-of-Systems" approach. This concept describes an approach in which different systems work together, and jointly provide the required services. Although this leads to an increased need for coordination and communication, it also allows for greater flexibility in meeting new demands and often extends to the further use and integration of existing legacy systems. This is particularly true if the necessary foundations for a "system-of-systems" approach have been laid in such a way that, on the one hand, simple connection to the system involved is made possible and, on the other hand, the operator retains sufficient control to enforce uniform rules. This ensures standardized data formats, unified protection mechanisms, and a uniform set of rules for data exchange.

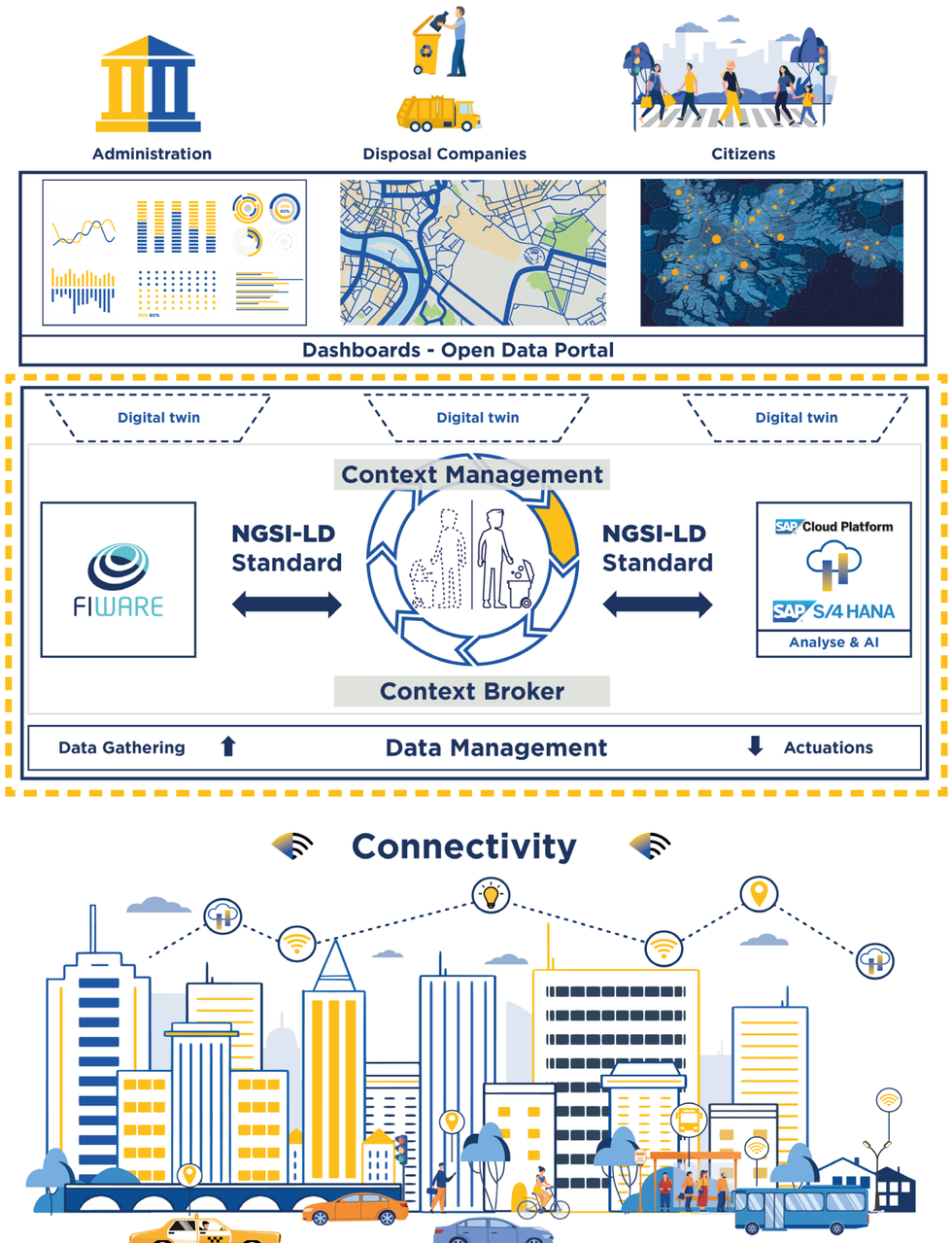
The Standard, the European Platform, and the Open Source Ecosystem

In today's Smart Cities "System-of-Systems" architectures are created on the basis of the ETSI standard "Context Information Management (ETSI ISG CIM)" also know as NGSI-LD. In addition to this standard, there are also recommended NGSI platform components supported by the European Union - the Context Broker, a component of the "Connecting Europe Facilities (CEF)" program for the creation of a uniform market for digital services in Europe. NGSI-LD is thus the uniform global interface format for the exchange of data in the field of Smart Cities. The implementation of the Context Broker as part of the curated FIWARE Open Source Platform provides further investment security. In the FIWARE Foundation, companies, organizations and universities from all over the world have come together to jointly maintain and further develop the Open Source Ecosystem.

Digital Twins, Context Brokering and Digital Continuity

The business concept behind the system-of-systems approach is the realization of the so-called Digital Twins, exact images of relevant objects of the real world in the virtual world of data networks. The Digital Twin is closely connected to its real "partner". IoT protocols constantly deliver the current state to the Digital Twin. In a System-of-Systems approach, the Digital Twin is also the object through which different systems communicate and synchronize with each other. The Digital Twin is represented in each of the participating systems, whereby each system, in turn, stores different data and can have different views of the Digital Twin. The Context Broker is used to connect the disparate systems and allows the owner (the city) to control its information flows and business processes. Continuity in the management and use of the Digital Twin across different application systems is the key element that allows the decision-making authority to design and create functioning Digital Processes.

Municipalities can use the “Digital Twin” concept to take the first steps in implementing Smart City use cases and without losing sight of the goal of sustainable intelligent networking. Existing approaches with small isolated test fields and pilot projects can be brought together via the Digital Twin concept. With this blueprint, the sustainable implementation of different use cases can be achieved. The following examples vividly describe the implementation in the environment of smart waste management and winter road clearance services.



Example I:
The intelligent waste glass container

The example of an intelligent glass recycling container illustrates the possibilities of the Digital Twins and the System-of-Systems approach. A glass recycling container is a typical urban object that enables the city to fulfill its waste collection tasks and the responsibility of sustainable management. Such a container is associated with a variety of urban tasks, usually involving various organizations.

The city, as the owner of the container, creates the required digital twin and provides the necessary meta-information (such as location, size, type, competent authority, etc.). Then it registers the digital twin with the FIWARE-based NGSI-LD Context Broker. In doing so, it determines which partners can use the twin and, if necessary, augment the existing data. First, the city uses the services of the local IoT service provider and installs LoRa sensors on the container to automatically record its degree of utilization. The service provider installs the hardware, connects it to the IoT network (e.g. LoRa), and adds the data to the digital twin.

The measured values are transmitted at regular intervals and updated on the digital twin of the IoT platform. As soon as the content of the glass container reaches a critical level, it must be emptied. In contrast to traditional methods, where emptying occurs to a fixed time schedule, this is now done on demand. Recognition of needs takes place via rules, e.g. in SAP IoT. This is used to trigger business processes automatically, e.g. the generation of an order for the external service provider or information to the responsible internal department. Different rules can be used to trigger different actions depending on the urgency. The service provider now carries out the various steps of the business process. For example, he asks for permission from the responsible clerk, combines different requirements into a common order, debits the corresponding items of the budget, and finally notifies the service provider who carries out the emptying. Information about the steps of the business process is also stored in the digital twin and thus becomes visible to other users of the twin.

Photo: Digitalagentur

Additionally, the company that was commissioned to empty the container now has access to relevant parts of the digital twin's data. For example, the current fill level can provide the company with the necessary information about the urgency of the emptying and optimize fluctuations in the available transport capacities. When emptying is complete, the state can be updated and this can be stored in the Digital Twin. This information can then be passed on to interested residents who, for example, have been waiting for a container to be emptied.

After the emptying process has been completed, the order fulfillment can be checked using the IoT infrastructure. The business processes are then updated and can then take the next steps (payment order, statistics, calculation of future usage).

Further optimization is the use of predictive analytics, such as SAP Predictive Analytics. Here, the historical level fluctuations with influencing events in a "future model" become predictive data. These could be, for example, mass events, holidays, or, as is currently the case, special events such as a Covid 19 crisis, which have an influence on the need for emptying. This makes it possible to switch from a time-based model to a demand-based model, which in turn influences the further planning of the city budget. Cities and regions that already use such a system report a reduction of driven kilometers by about 20% (e.g. NEC Cloud City Operation Center). This has a direct impact on costs, traffic, and especially on the environment.

Example II:
Digitally supported operation of winter road clearance

WinterSmart is an innovative and digital approach to sensor-based optimization of winter maintenance. It measures sensor-based information on slippery roads in real-time and passes this information on to the winter road clearance service for better coordination of the current spreading route planning. Salt container level measurements are also used to improve the planning of the salt inventory. This leads to a demand-oriented deployment and an optimized organization of the city's clearing and gritting services.

Fewer trips and demand-oriented clearing and spreading will increase efficiency, enhance safety, and sustainably improve the quality of winter services.

Photo: Digitalagentur

The solution is implemented by installing professional environmental measurement technology in the road surface for precise ice warning on, particularly exposed slopes. In addition, industrial sensors, which are connected via LoRaWAN, are used as additional sources of information about environmental events. A measurement of the filling levels of the salt silos and its visualization complete the sensor technology. During the construction of the solution, the creation of data silos is consistently avoided. Following this concept, the measured environmental data will be made available to the winter road clearance service and also be available to address further initiatives of the city in the field of environment and climate. In addition to the specialized LoRaWAN IoT Hub to collect the measured data, and SAP Leonardo IoT system will be integrated into an open interface. This will provide climate information for wider use by climate experts and citizens.

The examples selected here are representative of many other applications in the

field of the intelligent city. For example, more complex container types, such as press containers, also require maintenance, which can also be supported by sensor technology. Here, the usage behavior such as the opening of the loading hatch or the number of pressing processes is analyzed and the maintenance of the container is optimized based on this information. For this purpose, the digital twin of the container is managed with the focus on (predictive) maintenance in a maintenance system such as SAP PdMS.

Outlook

The Smart City Ecosystem can be the end and goal of the operationalization of digital and smart strategies of urban development. The processes and challenges depicted are derived from the general conditions. The integration of new data and process alternatives are already defined. The next step is to set up key figures or control parameters that make the quality of control measurable and transparently demonstrate the benefits of the solution. With the data from the digital twin, meaningful dashboards can be created that make the success of the control system visible. For time-critical processes, users are given the opportunity to directly read the effects of the measures via a cockpit.

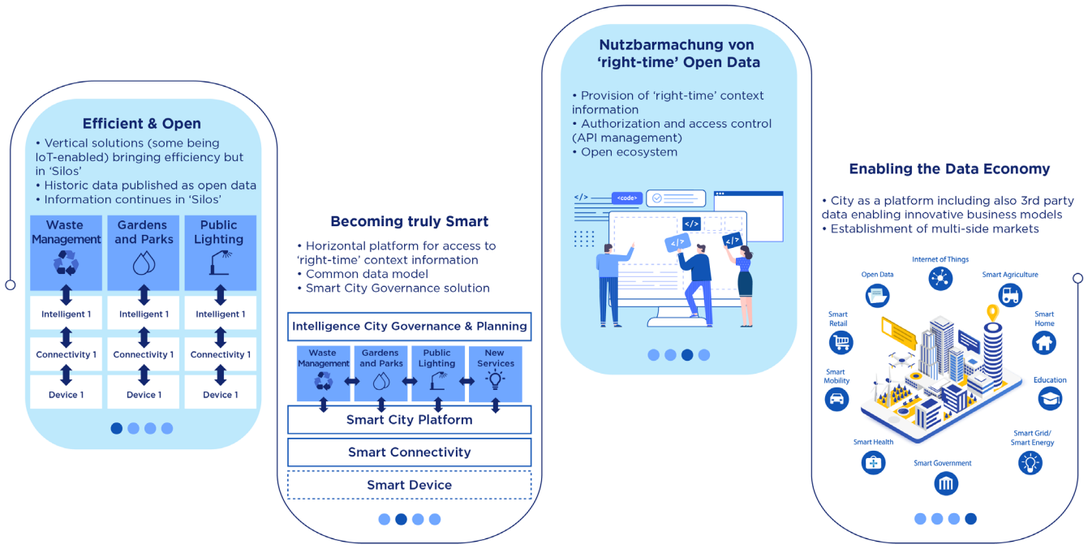
On the other hand, the system-of-system can also provide technical access to an open platform to support citizen-oriented services of public, private, or commercial nature. Here, the following steps are aimed at acceptance and use by municipal service providers in order to harmonize or link these with public services. In this way, the opportunities offered by the technology can be tapped in the city without having to relinquish control or prejudice solutions.

Ecosystem data form the basis for both sovereign urban use and for up-to-date, data-based, and informed decision-making.

The companies involved in this initiative provide the city with the partners to build a stable foundation as well as to provide targeted support for urban development without putting technology at the forefront.

This digital transformation process towards a Smart City is exemplified in the graphic below.

FIWARE: Digital transformation to Smart City



About FIWARE

FIWARE Foundation is a non-profit organization that drives the definition and encourages the adoption of open standards — implemented using Open Source technologies and reference architectures — to ease the development of smart digital solutions across multiple domains, based on FIWARE technology. The foundation achieves that through the support of a fast-growing global community that shares a common vision and combines their efforts toward making FIWARE the Open Source technology of choice for industries, governments, universities and associations to reach their full potential and scale up their activities, thereby, entering new markets and growing their businesses. Founded in 2016, the foundation has Atos, Engineering, Red Hat, NEC, Telefónica and Trigyn Technologies among its Platinum members. For further information, visit fiware.org and follow us on **Twitter, LinkedIn, Facebook** und **Youtube**.

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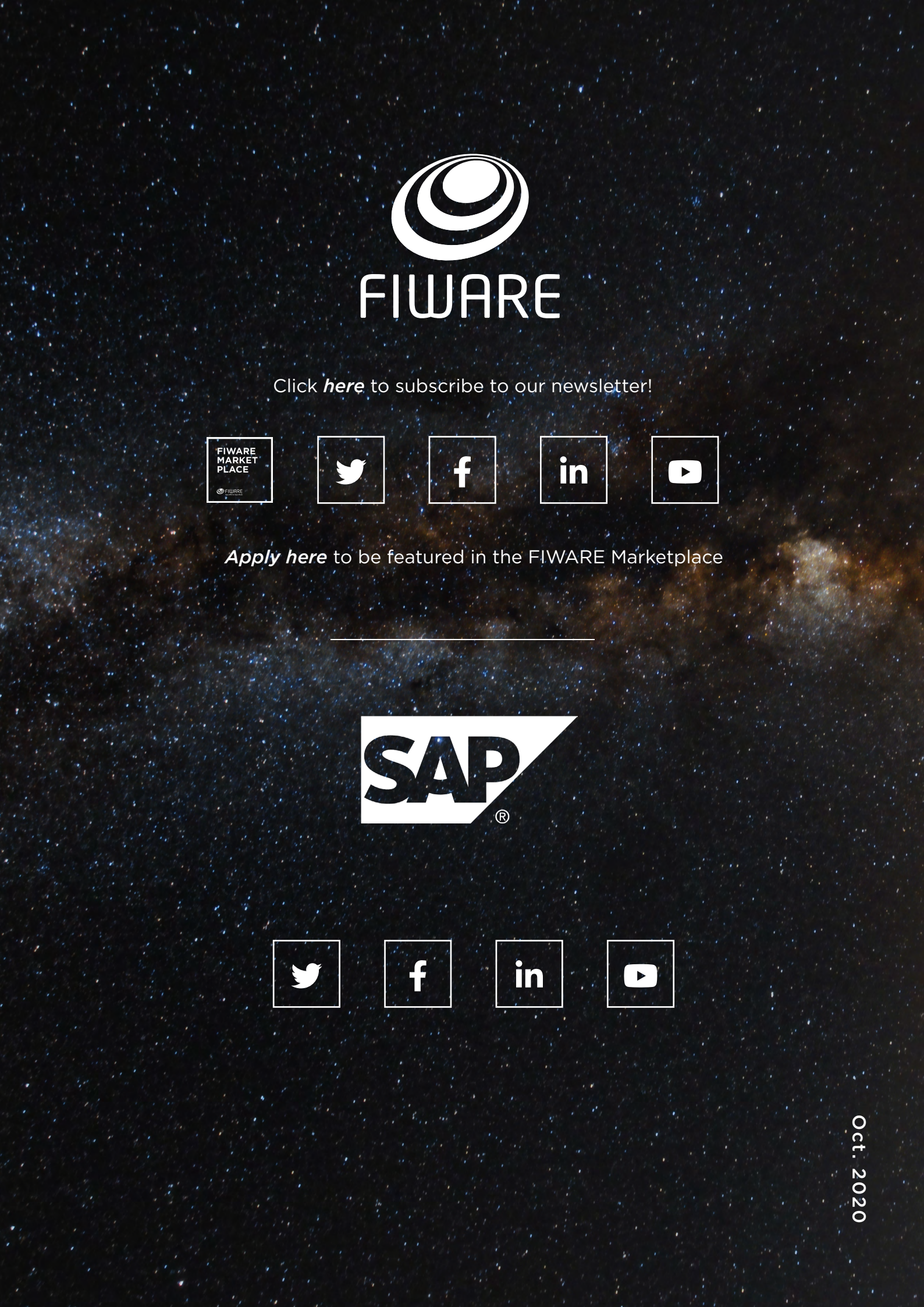

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Oct. 2020