Smart cities development based on S4ALLCities project

George SUCIU,
R&D department, BEIA Consult International, Bucharest, Romania

george@beia.ro

Daniel-Marian DUTU,
R&D department, BEIA Consult International, Bucharest, Romania

daniel.dutu@beia.ro

George IORDACHE,
R&D department, BEIA Consult International, Bucharest, Romania

george.iordache@beia.ro

Mari-Anais SACHIAN,
R&D department, BEIA Consult International, Bucharest, Romania

anais.sachian@beia.ro

Ana-Maria TUDOR,
Marketing department, BEIA Consult International, Bucharest, Romania

ana.tudor@beia.ro

Cornelia ALEXANDRU,
R&D department, BEIA Consult International, Bucharest, Romania

cornelia.alexandru@beia.ro

Victor SUCIU,
R&D department, BEIA Consult International, Bucharest, Romania

victor.suciu@beia.ro

Abstract

The global urbanization that happens nowadays raises the need for cities to face new challenges, which can vary from the organization of its resources to the protection of its population. For short, today, cities around the world need to become smart.

A smart city is a technologically developed urban area that uses different technologies and synchronized IoT systems that collect data from its sensors and devices in order to keep track of the current situation. This data can help organize resources, energy, traffic, cyber or physical attack alerts on events with large or restricted audiences. The smart-city concept integrates information and communication technology (ICT) and a certain number of physical devices and sensors placed around the city and connected to the Internet of Things. This article aims to present the existing technologies offered by the S4ALLCities project, useful for the development of a smart city, which will be described during the following part of this article.

Keywords: *IoT, Cybersecurity, ICT, Digital Twins*.

1. Introduction

Today, more than 60% of the planet's population lives in cities, and the trend is growing, according to Statista's Degree of Urbanization by continent [2]. For this reason, the need for cities to face new challenges in terms of organization and security is growing alarmingly worldwide, especially in Europe [3]. This is triggering many initiatives around the world, from city councils to companies, all wanting one thing in common: to make the city smart. Although still considered work-in-progress, the Smart city concept continues to be increasingly mentioned and opted for today. Most cities are looking for intelligent solutions to optimise their functioning. This term involves the combination of innovative ideas that include improvements, in general, to existing technologies, all usually borrowing the same principles from each other. The technologies borrowed by all innovative ideas are those related to IoT, cybersecurity and ICT.

The increased advances in ICT must improve management and environment operations. As a result, the problems of smart cities are also becoming difficult due to the high speed of change. This leads to constantly updated technologies that bring about organisational changes. These can be improved by gathering personal information about people, using mobile applications and social networks. [5]

According to The Department for Business Innovation & Skills of the UK, it has been estimated since 2013 that in 2020 the global market for smart city solutions will reach $408 billion, representing approximately 24% of the global market. The actual amount reached in 2020 was $410.8 billion and is estimated to grow to $820.7 billion by 2025. [6] [7]. An important factor driving the global growth of the smart city market is the interest of authorities in platform manufacturers over smart solutions. The majority of shareholders opt to use their platform.

The Internet of Things is an ever-growing paradigm that allows electronic devices to communicate via the internet. The IoT aims to make lives easier by providing innovative solutions to various challenges or problems related to government, public or business situations. They represent the combination of a

variety of smart devices, sensors and frameworks, with the advantage of providing storage space and high processing speed. (Fig. 1)

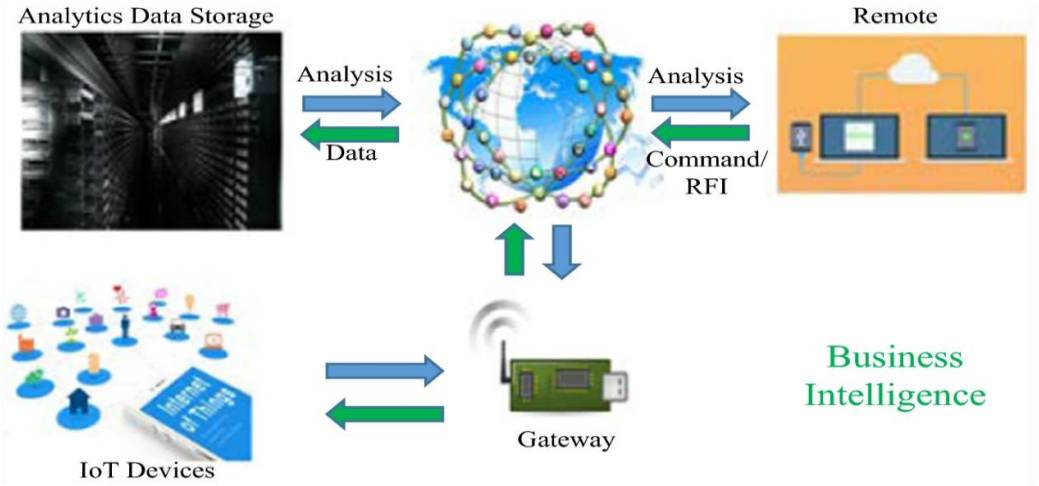

Fig. 1 General architecture of IoT
Source: [9]

IoT technology is the basis of the European Spaces Safety and Security for All Cities project, S4ALLCities for short, which aims to implement and assess cyber and physical security threat levels in smart cities via digitally augmented situational awareness. It is in continuous development and will focus on risk-based systems, dealing with security management, detecting suspicious activities, identifying illegal objects and real-time estimation of physical or cybernetic attacks from multiple locations, and providing countermeasures for crisis management. S4ALLCities will also play an important role in promoting the security of European cities.

2. Architecture

The S4ALLCities project aims to address the solution of smart cities optimization through modular subsystems, called digital twins, each of which contributes in a complementary way to the goal itself. These digital twins are specialized in real-time digital representation and machine understanding of processes and objects encountered in different open public spaces. (Fig. 2)

The Digital Twins are:

- Distributed Edge Computing IoT (DECIoT), which offers intelligent edge processing of measurements and sensors observations;
- Malicious Actions Information Detection Systems (MAIDS), which is responsible for machine detection and intelligent detection of suspect behavior;
- Augmented Context Management System (ACMS), responsible for information within a common operational picture and augmented reality.
- Thus, digital twins used together achieve high levels of awareness of possible risk situations in public spaces.

Fig. 2. Digital Twins
Source: [10]

The main objectives of the S4ALLCities project are:

- to develop an open platform aimed at information exchange and management, providing real-time situational awareness and decision support, thus increasing the resilience of European cities, while respecting the fundamental right of citizens to privacy;
- designing and developing an intelligent architecture for communication and interconnection of smart systems through IoT;
- completing smart city monitoring systems to improve preparedness and responsiveness in case of physical or cyberspace attacks.

3. Demonstrators

The S4ALLCities project will be validated in 3 European cities: Trikala (GR), Bilbao (ES) and Pilsen (CZ), where it will be installed and pilot tested for three months. Its benefits will be presented to stakeholders using different scenarios involving physical and cyber attacks on soft targets in the smart cities mentioned above. An example of a soft target could be public space, which is currently quite exposed to attacks of all forms. The demonstration events will showcase the effectiveness of the smart monitoring system by taking key measurements of city infrastructure (such as traffic, access to restricted areas, evacuation routes), detecting explosives, cyber-attacks and suspicious activity.

The pilot scenario in Trikala will focus on two important soft targets:

- the autonomous bus transportation;
- the park of Trikala;
- municipal buildings.

These two scenarios will demonstrate how the Digital Twins technology will handle the protection of crowds in public spaces or in autonomous bus transport infrastructure.

The Bilbao scenario will be based on detecting suspect behaviour, explosives and guidance of people to a safe place. This scenario is based on the 2017 terrorist attack in Cambrils when several pedestrians were attacked on the street by members of a terrorist organization. On the same day, 100km away, a van driven by another member drove into the crowd, killing 14 people and injuring many others. With the help of detection systems to be implemented, these grim scenarios can be prevented and stopped in time. [8]

The Malicious Actions Information Detection Systems will detect the anomalies and illicit behaviours of different individuals or groups of people in different crowded places situated in a high-risk area. The Augmented Context Management System will use the augmented reality technology to detect the explosives and suspected armed attackers. Furthermore, the early detection and protection of cyber-attack will be tested, its purpose being to avoid the loss of control over the information and systems involved in the scenario.

The demonstration in Pilsen will have insight into the evacuation of the football stadium. It can hold up to 15000 people, and if the surroundings, including a pedestrian zone, park and bus terminal, are taken into consideration, the number can be much more.

The scenario focuses on managing a crisis situation at the stadium in case of a terrorist attack or a leak of toxic ammonia gases from the neighbouring brewery. Its main purpose being the evacuation in safet of the people from the stadium and its neighbouring.

Another data collection method that will be further implemented in the S4ALLCities project is fibre optic networks for communications, which are already in large numbers in urbanised cities.

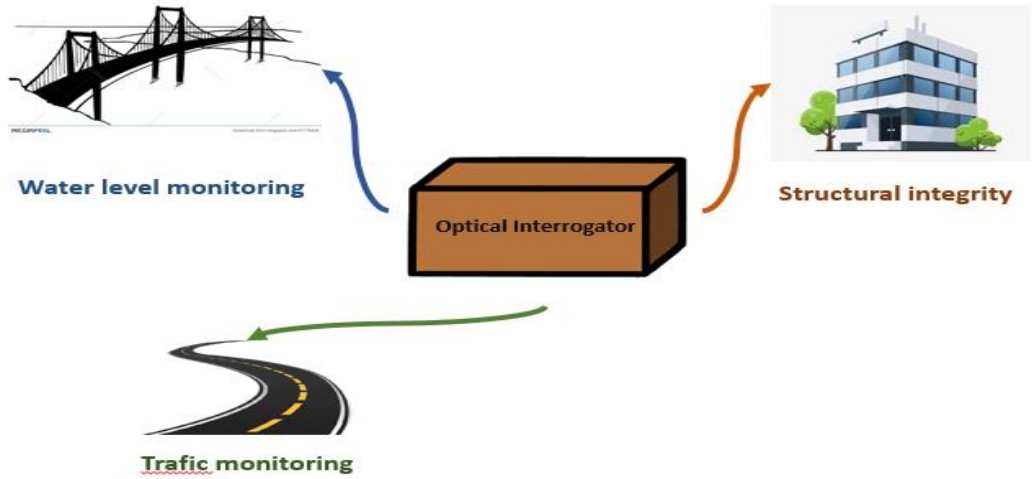

Fig. 3. Data collection using FBG

These can transmit various low data optical signals from various deployed sensors, which are positioned in locations with critical infrastructure. The sensors

will be Fibre Bragg Grating (FBG) sensors, which exhibit high accuracy at a low cost. (Fig. 3)

This System of the Systems aims to achieve a TRL-7 by the end of the project, showing the S4ALLCities functionality to the relevant end-users and stakeholders. [10]

4. Conclusions

At the conclusion of this paper, Smart Cities face difficulties due to far too rapid changes. The S4ALLCITIES project, through its solution, optimizes solutions through modular systems or, as they are also called, digital twins. These digital twins help determine possible risks in public spaces in the city. They will be validated for three months in three European cities: Trikala (GR), Bilbao (ES) and Pilsin (CZ). They will measure the city's infrastructure, such as traffic, access to restricted areas, detect possible explosions, cyber-attacks that may occur or suspicious activity.

Acknowledgements

This paper was partially supported by UEFISCDI Romania and MCI through Eureka ITEA projects PARFAIT and SOLOMON, and funded in part by European Union's Horizon 2020 research and innovation program under grant agreements No. 872698 (HUBCAP) and No. 883522 (S4AllCities).

References

[1] Kirimtat, A., Krejcar, O., Kertesz, A., & Tasgetiren, M. F. (2020). Future trends and current state of smart city concepts: A survey. Pages 1-2 *IEEE Access*, *8*, 86448-86467.

[2] Degree of urbanization (percentage of urban population in total population) by continent in 2020 https://www.statista.com/statistics/270860/urbanization-by-continent/

[3] Andrés Camero, Enrique Alba, Smart City and information technology: A review, Volume 93, 2019, Pages 84-94, ISSN 0264-2751,

[4] Kumar, S., Tiwari, P. & Zymbler, M. Internet of Things is a revolutionary approach for future technology enhancement: a review. *J Big Data* **6,** 111 (2019). https://doi.org/10.1186/s40537-019-0268-2

[5] A. Essa et al., Cyber physical sensors system security: threats, vulnerabilities, and solutions, in IEEE ICSGSC (2018), pp. 62–67

[6] S.A. Timashev, Cyber reliability, resilience, and safety of physical infrastructures, in IOP Conference Series: Materials Science and Engineering, vol. 481 (2019), p. 012009

[7] C. Konstantinou et al., Cyber-physical systems: a security perspective, in IEEE ETS (2015), pp. 1–8

[8] Huertas, Assumpció, and Andrea Oliveira. "How tourism deals with terrorism from a public relations perspective: A content analysis of communication by destination management organizations in the aftermath of the 2017 terrorist attacks in Catalonia." *Catalan Journal of Communication & Cultural Studies* 11.1 (2019): 39-58.

[9] Kumar, Sachin & Tiwari, Prayag & Zymbler, Mikhail. (2019). Internet of Things is a revolutionary approach for future technology enhancement: a review. Journal of Big Data. 6. 10.1186/s40537-019-0268-2.

[10] Smart Spaces Safety and Security for All Cities. Press release 2020 https://www.s4allcities.eu/press-release-01