Decentralized operation and security in the IoT Space

IoT: societal impacts and recommendations from SOFIE project

2020

Better business transparency and remote access are fundamentally important. The COVID-19 pandemic has forced us to operate in unprecedented times where a rapid transition to a more digitalised workflow is vital.

The 13th Cyberwatching.eu[1] webinar entitled "**Decentralized operation and security in the IoT Space**"[2] was held in collaboration with the **SOFIE project**[3], addressing the ongoing strong development of the Internet of Things (IoT), which is dramatically changing traditional perceptions of the current Internet towards an integrated vision in which smart objects interact with each other.

The webinar showcased how decentralized operation and security in the IoT Space help our society and economy, providing the following takeaways:

- Valuable learning opportunity from the European IoT and CS&P experts who shared their experience;
- Gaining insights into the SOFIE architecture being developed in the SOFIE project currently used to power four pilots: the supply chain, the energy flexibility marketplace, context-aware mobile gaming, and energy data exchange;
- Discovering the cybersecurity resources which small-medium enterprises (SMEs) and projects could benefit from, particularly in the current situation where cybersecurity skills are more needed than ever before.

[1] https://www.cyberwatching.eu/
[2] https://www.cyberwatching.eu/decentralized-operation-and-security-iot-space
[3] https://cyberwatching.eu/projects/1302/sofie

The Sofie project: full alignment with EU Policies addressing societal impacts

SOFIE[4] project enables interoperability between existing IoT platforms through distributed ledger technologies (DLTs). SOFIE Framework is demonstrated in four real-world pilots: food supply chain, energy flexibility marketplace, context-aware mobile gaming, and energy data exchange.

The SOFIE pilots are providing impacts on the EU's societal challenges and give recommendations to the future funding programme Horizon Europe and the Digital Europe Programme. The recommendations were compiled by Giuseppe Raveduto (Engineering[5]), Spyros Voulgaris (AUEB[6]), Priit Anton (Guardtime[7]) and Ahsan Manzoor (Rovio[8]) and edited by Liis Livin (Guardtime).

1. SOFIE energy flexibility marketplace pilot

Impact on the corresponding societal challenges

The decentralized energy flexibility marketplace pilot of the EU H2020-funded project SOFIE explores the application of blockchain technology and self-enforcing smart contracts in the context of a peer-to-peer flexibility marketplace in which a fleet of electric vehicles and Distribution System Operators (DSO) can cooperate to balance the production from renewable energy sources with the consumption of the electric vehicles.

The pilot combines a rapid and user-friendly mechanism to negotiate micro-contracts "on the fly", the security, transparency, and auditability of the operations granted by the blockchain, and interoperability among different siloed IoT systems, thanks to federative approach. The penetration of distributed renewable energy sources and electric vehicles' supply equipment poses new challenges for the DSOs that need to dramatically increase their hosting capacity.

The flexibility marketplace aims to reduce the peaks in renewable production and electric vehicles' (EV) consumption, contributing to reducing maintenance, costs optimising the usage of the existing infrastructure.

EVs are considered flexibility resources, their load can be connected to different areas and modulated in power, providing services useful in avoiding network congestion, like consumption or production peak shaving or load shifts.

Thanks to the collaboration activated by the marketplace, the DSO can handle energy losses, voltage deviation, the transformers overload and reverse power flow, while the fleet managers can reduce the operational costs thanks to the energy retail marketplace and the incentives awarded by participating in flexibility campaigns. Given the interconnection between electricity networks, the stability of the grid at the EU level depends on the stability of the regional networks and so a decentralized approach may

[4] https://www.sofie-iot.eu/
[5] https://www.eng.it/
[6] https://www.aueb.gr/
[7] https://guardtime.com/
[8] https://www.rovio.com/

contribute to the integrity of the whole system.

The ability to increase the consumption from renewable sources without interfering with the normal activities of the EV fleet is highly attractive considering the increasing interest in the ***green mobility*** field since it also contributes to CO2 emissions reduction (compared to the same amount of energy if it were taken from the grid).

At the same time, the interaction with the underlying IoT platforms (EV monitoring, EVSE management, smart meters and monitoring infrastructure) being tested in the pilot opens new possibilities in a "*smart city*" scenario, in which (near) real-time data will be more and more valuable for the development of new services.

Recommendations regarding the future funding programme Horizon Europe and the Digital Europe programme

The European Commission has already implemented a range of initiatives to achieve a resource-efficient and environmentally friendly transport system, supporting smart electric mobility in urban areas and the integration of fast charging with the existing infrastructure. Although such initiatives already produce benefits for the economy, society, and citizens, the lack of a uniform regulatory framework in Europe produces fragmented results at the level of individual states.

One potential solution may be to monitor the application of relevant research results within a homogeneous European regulatory framework. Our second suggestion is to continue to support programmes for the creation, development, research and innovation of transport and storage energy infrastructure in support of fast charging infrastructure and smart green mobility.

2. SOFIE food supply chain pilot

Impact on the corresponding societal challenges

The Food Supply Chain pilot of the EU H2020-funded project SOFIE explores the use of Distributed Ledger Technology (DLT) for improving product quality and safety control in food supply chains through transparent, trusted, and secure end-to-end traceability frameworks. The emergence of the Internet of Things (IoT), as well as big data analytics and autonomous robotics, have driven the development of such traceability systems in the last few years.

Nevertheless, the majority of the proposed solutions still rely on heavily centralized infrastructures and central control authorities to manage data and offer end-to-end services. As a result, this limits transparency and, by its very nature, creates major concerns related to data security and integrity, protection of enterprise (sensitive) data, and building of mutual trust between chain members. In this scope, blockchains represent an innovative technological solution not only to support automation in data and the transactions management but also to build trust among entities.

Along these lines, the SOFIE project explores the capabilities of blockchain technology in securing product quality and optimizing supply chain management. In order to protect sensitive enterprise data and keep the overall operational cost low and the transaction throughput high, SOFIE investigates the use of a range of hybrid blockchain topologies and interledger technologies to orchestrate food supply chain traceability frameworks.

The different architectures affect performance criteria related to the cost, the speed and the throughput of transactions. Combining different types of ledgers, and in particular public and private blockchains, allows different trade-offs in terms of trust decentralization, transparency, privacy, transaction cost, and delay.

Recommendations regarding the future funding programme Horizon Europe and the Digital Europe programme

Using our research as a starting point, future projects may build on our findings to expand them in various directions. A very interesting direction concerns the extension of our framework to support vast supply chains, far exceeding the size and constraints of agricultural products.

This entails a new design based on far higher scalability requirements, as the target system should be able to transparently and immutably record not only the transactions of a single supply chain, but rather the transactions recording all merchandise trade at a national, European, or even global level. This inherently calls for multi-level hierarchical structures, as well as, for generic application programming interfaces (APIs) able to cover the specific requirements of a very diverse range of supply chains. Besides being generic, these APIs should be extensible by design, allowing the inclusion of new product chains with custom specifications and traceability rules, to be future-proof, enabling the integration of currently unknown product types that will emerge in the future. Additionally, the role of public authorities, including the authorities of individual member states and at the EU level, in the governance and management of private blockchains to handle cross-border transactions in the EU is significant to ensure the gains of blockchain technology throughout the EU.

On another note, as the area of blockchains is still undergoing massive research activity, it is expected that new types of distributed ledgers with probably unpredictable properties will emerge, which will provide a new basis for research projects targeting product quality in supply chains.

The creation of hierarchical blockchain architectures that can adapt to take advantage of emerging features of future distributed ledgers is necessary.

3. SOFIE energy data exchange pilot

Impact on the corresponding societal challenges

The energy data exchange pilot of the EU H2020-funded project SOFIE is closely related to granting governance and access control to energy consumption and production data. Using Verifiable credentials, Decentralised identifiers in combination with the DLT approach and Guardtime's KSI blockchain, the way of applying the GDPR privacy rules is provided to existing energy networks.

The direct impact from SOFIE comes by providing means on how data can be accessed when the Energy sector landscape from 20% renewable energy sources (RES) is to change into 50% of RES by 2040. Solving the challenge to build more decentralised energy grids, especially from a production perspective, but also by providing energy flexibility at the household level, requires technological improvements on different levels. One of these, the liberation of data from stand-alone legacy systems, is the task that

SOFIE energy data exchange can contribute to. We are providing a practical solution to the EU's Digital Single Market Strategy opening up cross border data exchange and making use of smart metering and sustainable and low-carbon energy services that are required by the EU 2020 Strategy for energy and Renewable Energy Directive.

Recommendations regarding the future funding programme Horizon Europe and the Digital Europe programme

One important avenue of research from the Horizon Europe perspective is to have the energy networks include application-level security measures, such as user authentication and role-based access control, in addition to measures of telecommunication networks adapted to the operational context, such as firewalls, intrusion detection systems, hop authentication and data encryption.

From user authentication and role-based access control, decentralised identifiers and a combination of Public Key Infrastructure and blockchain-based certificate handling (Decentralised Identifiers) could be investigated.

4. SOFIE context-aware mobile gaming pilot

Impact on the corresponding societal challenges

The context-aware mobile gaming pilot of the EU H2020-funded project SOFIE is to explore how Distributed Ledger Technologies (DLT) can be used to provide new gaming features for players, as well as to validate the potential of location-based IoT gaming use cases. The mobile gaming pilot demonstrates the strength of the SOFIE approach in several key areas, including the reuse of existing IoT infrastructure and experimenting with a business platform which is open for third parties, such as the owners of public spaces and businesses. Blockchain games benefit from the features of DApps: non-fungible tokens and system transparency. The blockchain system fulfils the dream of many game players: the items they own in the virtual world are non-fungible, exchangeable, inheritable, and independent of the game service provider. Though these games are still in their preliminary stage, the relationship between players and game companies has been completely changed through such a new concept. However, the lack of sustainability and consumer stickiness has also become a problem and blockchain games sudden increase goes through a steep decline in a short time. One of the reasons for this is blockchain games on the market now still lack playability compared to traditional games.

Recommendations regarding the future funding programme Horizon Europe and the Digital Europe programme

Blockchain has the potential to become a disruptive technology for the game industry. Blockchain games may introduce new research directions, for example, new consensus models or alternative technologies for blockchain games should be investigated, with the purpose of improving players' gaming experience with blockchains, or new mechanics from the idea of blockchain should be developed to enrich the gaming contents. Blockchain games need more research and leading products to drive the growth of the whole industry and attract more public attention.

Workshop Speakers:

- **Nicholas Ferguson**, project manager at Trust-IT[9] Services and Project Coordinator of Cyberwatching.eu, who provided an exhaustive overview of the Cyberwatching.eu project and one of its goals as coordinating support action (CSA) in promoting project results and outputs to increase their visibility and reaching a wider pool of the cybersecurity and privacy community.

- The moderator of the webinar was **Prof. George C. Polyzos**, who leads the Mobile Multimedia Laboratory at the Athens University of Economics and Business (AUEB)[10] and is a Professor of Computer Science and Director of the Graduate Program in Computer Science. He provided the broader sense overview of IoT space and where SOFIE fits in and what kind of results were produced.

- The second speaker was **Santeri Paavolainen**, currently working as a doctorate researcher at the Department of Communications and Networking in the School of Electrical Engineering at the Aalto University[11] in Finland, who presented how to utilize multiple distributed ledgers in an IoT environment. Different ledgers are tailored to different use cases and combining different ledgers in a single system produces significant benefits in terms of security, privacy, scalability, and costs.

- The third speaker was **Prof. Vasilios A. Siris**, an Associate Professor at the Department of Informatics and a member of the Mobile Multimedia Laboratory at Athens University of Economics and Business, Greece, who introduced Decentralized identifiers (DIDs), which are a new type of identifier that enables verifiable, decentralized digital identity.

[9] https://www.trust-itservices.com/
[10] https://www.aueb.gr/
[11] https://www.aalto.fi/en

- The fourth speaker was **Priit Anton**, a program manager and business analyst at Guardtime[12] dealing with customers' specific requests and business development, who discussed how building solar panels and wind farms do not solve all the future energy challenges and said the data accessibility and security problems are essential in creating a greener, more sustainable energy market and SOFIE has a strong role to play here.

- The fifth speaker was **Giuseppe Raveduto**, an engineer in computer science working as a researcher in Engineering's R&D laboratory[13], who presented how solar panels and electric cars can work together in the same scenario and how the accurate production forecasts, possible with the use of IoT smart meters, local flexibility requests can be created in a decentralised energy flexibility marketplace.

- The sixth speaker was **Max Samarin**, game design and development professional who is currently doing research work at Rovio Entertainment[14], who spoke about researching potential use cases of Distributed Ledger Technology (DLT) and the IoT in gaming.

- The last speaker was **Spyros Voulgaris**, an Assistant Professor in Computer Science at Athens University of Economics and Business, who presented the enhancing supply chains' quality control and provenance tracking by registering product handling and how shipment on blockchains is generally perceived as a killer-app for Distributed Ledger Technology (DLT).

[12] https://guardtime.com/
[13] https://www.eng.it/
[14] https://www.rovio.com/

Watch the recorded workshop video now!

You may also download the speakers' presentation at the webinar page: https://cyberwatching.eu/decentralized-operation-and-security-iot-space.

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