Periodic Reporting for period 1 - TERMINET (nexT gEneRation sMart INterconnectEd ioT)

Reporting period: 2020-11-01 to 2022-04-30

Summary of the context and overall objectives of the project

The Internet of Things (IoT) is enabled by heterogeneous technologies, devices, and platforms that work together towards providing data sensing, collecting, managing, and processing. In IoT, intelligent
embedded devices, such as smart sensors, wearable devices, and autonomous cars, are interconnected and autonomously able to communicate inside the IoT framework. However, conventional cloud computing and IoT solutions are not able to support real-time applications since they are designed to offer non-real-time services. Connecting, configuring, and managing vast numbers of heterogeneous devices in the traditional way, e.g. manually, statically, and per IoT domain, is no longer feasible. Additionally, the integration of Artificial Intelligence (AI) technology in the IoT domain is an efficient method for developing intelligent services for offering predictive analytics or generating significant insights. Consequently, effective synergies of IoT and AI are needed to facilitate organizations to gain high-quality insights into every piece of data. Finally, businesses rely heavily on the incorporation of cutting-edge Information and Communication Technology (ICT) innovations. In this respect, Augmented Reality (AR), Virtual Reality (VR), and Digital Twins (DTs) can have a substantial impact on the growth of businesses by providing efficient methods to visualise the status of essential processes and equipment, hence decreasing downtime and associated expenses.

In the light of the aforementioned remarks, the TERMINET project aims to:

(a) apply distributed AI at the edge by using accelerated hardware and sophisticated software to support local AI model training using federated learning
(b) reduce the complexity of the connecting a vast number of heterogeneous devices through a flexible Software Defined Networking (SDN)-enabled middleware layer
(c) design, develop, and integrate novel, intelligent IoT devices such as smart glasses, haptic devices, energy harvesting modules, smart animal monitoring collars, AR/VR environments to support new market-oriented use cases
(d) foster AR/VR contextual computing by demonstrating applicable results in realistic use cases by using cutting-edge IoT-enabled AR/VR applications
(e) design and implement IoT-driven a decentralised and distributed blockchain framework within manufacturing, for supporting maintenance and supply chain optimisation
(f) apply vertical security by design methodology, thus, satisfying the privacy-preserving and trust requirements of the NG-IoT architecture
(g) outline novel, disruptive business models, while fostering standardisation activities for the IoT ecosystem
(h) validate and demonstrate six proof-of-concept, realistic use cases in compelling IoT domains, including energy, smart buildings, smart farming, healthcare, and manufacturing

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

In this period, the TERMINET project has achieved several goals with respect to the technical development of the project. In particular, WP2 delivered the design of a new architectural approach for edge and cloud communication, that is suitable for IoT data streaming and processing, based on the defined requirements. The architecture was designed to operate across the Edge-to-Cloud continuum focusing on Federated Learning-enhanced Deep Learning where data remain as close to the source are possible, thereby preserving the data privacy, optimising resource allocation, and delivering optimised AI models. This is reflected in the deliverables D2.1 D2.2 and D2.3 and the accomplishment of milestones MS1 and MS2. Based on this design, WP3 designed a platform that leverages the MEC paradigm (T3.1) and combines it with containerisation (T3.4 T3.5) and SDN technologies to offer a
flexible and scalable platform able to process diverse data flows across the Edge-to-Cloud continuum (T3.2 T3.3). This progress is reflected in D3.1 and the accomplishment of MS3. On the other hand, in WP4, the TERMINET project fully exploited the Federated Learning paradigm to train Deep Learning models using IoT data originating from end-users participating in the TERMINET use cases. In more detail, two different Federated Learning architectures were developed and are currently being tested, namely a Centralised and a Secure Decentralised Federated Learning approach (T4.2 and T4.3). These approaches were employed in consideration of the research done in hardware acceleration to optimize the training and model deployment (T4.1). To enhance the deployment of the developed Deep Learning models, a model personalization method was also employed, based on the method of Active Learning (T4.4). All the work covered in WP4 was monitored and validated by the GDPR-compliant guidelines in-development (T4.5). Additionally, to establish the security of information exchange within TERMINET, WP5 is in the process of investigating and developing the necessary security mechanisms and components (T5.1) to ensure data access by the appropriate services and only authorised devices (T5.2 T5.3) connected to the platform (T5.4). Furthermore, WP6 is targeting the design and development of applications able to utilise the AR/VR haptic components (T6.2) assisting domain experts with the least possible latency (T6.1). Moreover, WP6 is aiming at the integration of Digital Twins for predictive analytics (T6.3) the IoT device inventory (T6.4) and a user-friendly front-end panel (T6.5). WP7 is overseeing the deployment of a CI/CD platform (T7.1) to accommodate the development and integration of TERMINET components, validate their functionality, and unify them under one platform (T7.2 T7.3). Finally, all TERMINET research outcomes of this period have been disseminated through scientific publications in journals, conferences, and workshops.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

The innovative points of each TERMINET component reflect how TERMINET goes beyond the state of art. More specifically, TERMINET aims to enhance the final user’ services by bringing the decisions to the point of interest in a more efficient and accurate way. This will be achieved by reducing the complexity of connecting a vast number of heterogeneous devices through a flexible SDN-enabled middleware layer, applying distributed AI at the edge by using accelerated hardware and sophisticated software to support local AI model, and training using Federated Learning. Designing, developing, and integrating novel, intelligent IoT devices, such as smart glasses, haptic devices, energy harvesting modules, smart animal monitoring collars, AR/VR environments, and autonomous drones to support new market-oriented use cases are also between project scopes. Additionally, TERMINET will foster AR and VR contextual computing by demonstrating realistic results based on the use cases that will take place by using cutting-edge IoT-enabled AR/VR applications. Furthermore, through TERMINET, a decentralized and distributed blockchain framework will be designed and implemented in order to support supply chain maintenance and optimization within an IoT-driven system, and at the same time, vertical security by design methodology will be applied, which will satisfy all the privacy and trust requirements of the NG-IoT architecture. Finally, TERMINET aims to provide new business models and standardization activities for the IoT ecosystem. Through
six proof-of-concept and realistic use cases, TERMINET will validate and demonstrate the above scopes and goals with real data from modern IoT domains.

Related documents

TERMINET LOGO.png

Last update: 16 April 2023

Permalink: https://cordis.europa.eu/project/id/957406/reporting

European Union, 2024