Decentralised technologies for orchestrated cloud-to-edge intelligence

Reporting

Project Information

DECENTER

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Closed project

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Periodic Reporting for period 3 - DECENTER (Decentralised technologies for orchestrated cloud-to-edge intelligence)

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Summary of the context and overall objectives of the project

The field of artificial intelligence (AI) is developing rapidly, with new applications emerging that are filtering down into many areas of everyday life, yet many of these applications are quite resource-intensive. This may be an issue for those applications that exploit Internet of Things (IoT) sensors and devices for which sending to-be-processed data in a far away cloud instance might take too much time, consume too much bandwidth, or present privacy concerns. Indeed, those applications would benefit from computational capabilities close to where data is originated. The challenge is that such

resources, located at the edge of the infrastructure, are resource constrained, isolated, and not ready to support complex AI-based applications.

Besides the end users of the AI, there are at least two other key groups of stakeholders involved: application developers and infrastructure operators, with their different goals and perspectives. While the developer must focus how powerful, accurate, and responsive the proposed AI method is, on the other hand, the infrastructure spanning between the cloud and the edge shall be effectively managed, meaning that the operator has to decide how the applications run, schedule them, monitor and analyse the consumption of resources and make sure that the quality perceived by the end users is adequate.

To address such a gap and address the aforementioned challenges, DECENTER has developed platforms and tools that support application developers in creating AI-based cloud-native applications and infrastructure operators in operating them in what is now called the cloud-to-edge continuum.

The technologies proposed by DECENTER are paving the way to the introduction of novel services for the civil society and for the general public. For instance, it will allow municipalities to deploy real-time AI applications protecting the safety of citizens in public spaces (e.g. crossings) by detecting dangerous situations and triggering immediate alarms. DECENTER can offer outstanding benefits in other scenarios such as construction sites, logistics and homes, which are, together with the smart city, the four real-world pilots through which the project has validated its concept and approach.

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

DECENTER provides platforms and tools to create AI-based cloud-native applications and operate them in the cloud-to-edge continuum. Cloud-native applications are composed by set of independent modules (containers) that can communicate among them, gather information from sensors, provide inputs to actuator and other active devices or modules. Some of these containers may contain trained AI models, some other may provide other functionalities, e.g. a database, a web-interface, etc.

The DECENTER platform offers the capability to assemble different containers, and to dinamically create an AI-based cloud-native application that is then deployed in the infrastructure. Resource optimisation algorithms can be easily introduced, according to the need of the operator: the consortium has researched a set of solutions that minimise the utilisation of resources in the cloud-to-edge continuum while catering to the specific requirements of each application. It may also be the case in which the resources of the infrastructure provider are not sufficient to deploy applications; for such cases, DECENTER proposed a blockchain-based brokerage platform to host negotiation and seal contracts among parties, leading to automated federation of resources. A monitoring system supports these operations, providing data through which the quality of service that DECENTER can offer is assessed. IoT middlewares integrated within the DECENTER platform offer the capabilities of collecting data from sensors and other appliances directly at the edge of the infrastructure, offering the possibility to analyse them in a timely-effective manner in the fog nodes in which the AI containers have been deployed.

Tools and services are useful to create containers, enable cross-border data sharing, provide security, and much more. The project investigated methods to optimise AI models in order to facilitate their deployment in resource-constrained edge nodes. Concerns related to the management of data were addressed, especially in the context of cross-domain activities, in which the inherent trust offered by blockchains can help. AI applications can benefit from other essential services: DECENTER designed a data model for digital twins and proposed to reuse the data brokerage capabilities of IoT platforms to enhance such digital representation with both sensor data and AI elaborations. Other DECENTER services offer basic tools to create containerised AI applications and to secure the edge nodes and AI applications.

DECENTER Consortium has demonstrated that through its technology it is possible to detect and notify dangers for pedestrian in smart crossing in less than 100ms, reduce of a factor of almost two the CPU consumption of logistic robots running AI methods (thus increasing their availability and reducing energy consumption), increase privacy while preserving safety in smart construction sites, and reduce the size of complex AI models (e.g. less than half the parameters) to run them on resource-constrained edge devices, in order to speed up computation time and save bandwidth.

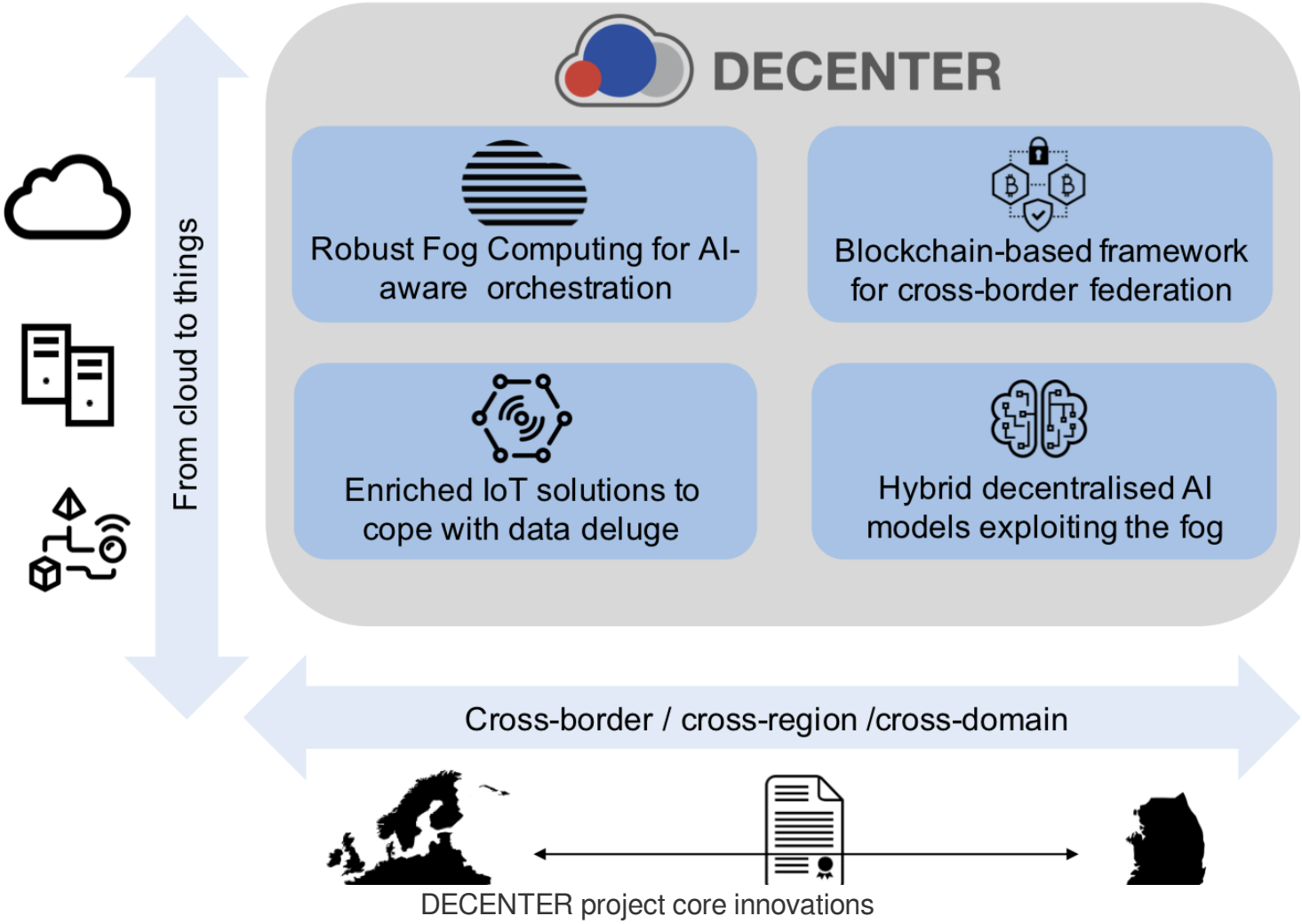
Outcomes have been disseminated through scientific publications (15 journal and 19 conference papers), and communicated through the project's website and social networks, as well as through international events. Three assets reached a TRL of 7, leading to relatively short-term commercial perspectives. These exploitations take different form, including the creation of a dedicated startup company. Related to project results, 15 patents were also filed. Finally, EU and KR efforts were dedicated to standardisation, with contributions to ISO/IEC standards.

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 service orchestration platform, the blockchain-based brokerage platform, the AI model optimisation for decentralised execution and the integration of IoT and digital twins for distributing and elaborating a virtual scenario, based on data from AI and sensors, are the four relevant innovations of the project.

DECENTER project is targeting substantial impact from the following angles:
- Technological impact of the DECENTER results for the European and Korean cloud and IoT ecosystems: DECENTER introduces key innovations that provide added-value over Cloud-to-Edge platforms existing in the market. Industry and Research Community will be able to take advantage of DECENTER innovations and knowledge, that will foster the evolution of the technologies developed within the project.
- Business and industrial impact on European and Korean competitiveness: The innovative solution provided by DECENTER will generate new business opportunities for its stakeholders, who will be able to deliver new products or improve their existing ones with a competitive advantage over their competitors. DECENTER consortium is committed in promoting the project outcomes among industry,

particularly among SMEs working in Cloud, Edge, IoT and AI domains.
- Societal impacts for the future smarter life: the development of the technologies involved in DECENTER will have a positive impact on society. New products and services will arise to help citizens and eScience community and increase their quality of life.



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