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In the published version of this decision, some information has been omitted, pursuant to articles 30 and 31 of Council Regulation (EU) 2015/1589 of 13 July 2015 laying down detailed rules for the application of Article 108 of the Treaty on the Functioning of the European Union, concerning non-disclosure of information covered by professional secrecy. The omissions are shown thus […]		PUBLIC VERSION This document is made available for information purposes only.

Subject:

State Aid SA.102498 (2023/N) – France
State Aid SA.102516 (2023/N) – The Netherlands
State Aid SA.102517 (2023/N) – Germany
State Aid SA.102527 (2023/N) – Poland
State Aid SA.102520 (2023/N) – Hungary
State Aid SA.102514 (2023/N) – Spain
State Aid SA.102519 (2023/N) – Italy

Important Project of Common European Interest on Next Generation Cloud Infrastructure and Services (IPCEI-CIS) – RRF

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Excellency,

1. PROCEDURE

(1) In October 2020, the 27 Member States of the EU signed a Joint Declaration for a European cloud federation initiative to shape the next generation of secure, energy efficient and interoperable cloud supply for Europe ([1]). The Member States stated their willingness to cooperate and co-invest in cloud computing technologies, aiming to deploy innovative capabilities, establishing a common set of technical rules, creating synergies and enhancing national and cross-border projects. These objectives would be implemented hand in hand with an investment plan, involving both European and national funds. Through this process, a new Important Project of Common European Interest (IPCEI) emerged.

(2) In December 2020, France, Germany, Italy and Spain invited all Member States to participate in the design phase of this IPCEI. Through this process, the scope and objective of an IPCEI on Cloud Infrastructure and Services (CIS) was defined: to establish the first Multi Provider Cloud Edge Continuum in Europe. The IPCEI aims to strengthen the creation of a cloud and edge computing domain, in line with the EU's objectives and strategies with respect to digital policy and transformation, as laid down in the Communications "A European strategy for data" ([2]), the "2030 Digital Compass: the European way for a digital decade" ([3]) as well as the Data Act ([4]).

(3) In 2021, multiple Member States launched national calls for preselecting potential projects and, held several technical meetings (with the participation of the European Commission (the "Commission") to design, prepare and develop a common programme for an IPCEI.

(4) Between 4 April 2022 and 4 May 2022, France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain pre-notified their plans to participate in an IPCEI CIS on the basis of a common draft overall descriptive text (so-called "Chapeau" document) explaining how the individual projects would meet the conditions of the IPCEI Communication ([5]).

([1]) The definition of cloud is provided in recital (9).

([2]) COM/2020/66 final, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A European strategy for data, COM(2020) 66 final, 19.2.2020, ("European Data Strategy").

([3]) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – 2030 Digital Compass: the European way for the Digital Decade, COM(2021) 118 final, published on 09.03.2021 ("2030 Digital Compass").

([4]) The Commission's proposal for a Data Act (COM/2022/68 final Proposal for a Regulation of the European Parliament and of the Council on harmonised rules on fair access to and use of data, COM(2022) 68 final), as further refined, has been voted by the European Parliament and Council. The final text has not been adopted yet. ("Data Act").

([5]) Communication from the Commission, Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest (OJ C528/10, 30.12.2021), ("IPCEI Communication").

(5) The Commission requested and received complementary information from all the participating Member States listed in recital (4) (the "Member States") during the period between June 2022 and November 2023.

(6) On the following dates, the Member States notified under Article 108(3) of the Treaty on the Functioning of the European Union ("TFEU") State aid for the execution of IPCEI CIS: Italy on 18 October 2023, the Netherlands, Spain and Hungary on 19 October 2023, Germany on 20 October 2023, Poland and France on 24 October 2023. All the Member States have individually notified the common Chapeau document and a project portfolio of their individual aid measures.

(7) By letters accompanying each notification, each Member State agreed to waive its respective right deriving from Article 342 TFEU in conjunction with Article 3 of Regulation 1/1958 ([6]) and to have this Decision adopted and notified in English.

2. OBJECTIVES AND DESCRIPTION OF IPCEI CIS

2.1. Background and main technical result of IPCEI CIS

(8) By participating in IPCEI CIS, the Member States endeavour to establish the first Multi Provider Cloud Edge Continuum in Europe in order to provide an open environment for data processing services based on a network of interconnected clouds and edges.

(9) Cloud is a set of specific hardware resources of a specific company, that substitutes the data processing of personal computers (PCs) and in-house infrastructures with data processing services offered on-line by a third-party in one single centralised hardware. As this outsourcing process results in a time delay in the data processing, i.e. latency ([7]), additional hardware is employed for this activity (i.e. edges ([8])) and installed closer to the users, in a decentralised manner ([9]). Currently, the connections between cloud, edges and the users mainly exist as proprietary and integrated solutions of single cloud providers. These proprietary solutions establish closed ecosystems of cloud and edge services which bind users to solely utilise the cloud and edge services of a single provider and limit users' freedom of choice and their ability to simultaneously use offers from diverse suppliers. The aim of the Multi Provider Cloud Edge Continuum is to enable the operation of this connection and data processing by different

([6]) Council Regulation No 1/1958 determining the languages to be used by the European Economic Community, as amended (OJ 17, 6.10.1958, p. 385).

([7]) An example of latency is when one uses a navigation application and their real-time position is reflected in that application with a delay, resulting in non-simultaneous and potentially incorrect navigation guidance.

([8]) These decentralised data processing devices are called edge nodes. For instance, a mini data centre, a server, a computer or a mobile device which serves as an internet of things (IoT) gateway with data processing capabilities can be an edge node.

([9]) This means that they are not installed as part of one single, centralised facility performing data processing, but they are numerous facilities, installed in different geographic locations and thus covering the same (or larger) geographic area while being at a smaller distance from the users.

providers of diverse cloud and edge offerings. This requires that the provider services are connected, i.e. federated. To this end, IPCEI CIS aims to develop software that: (i) will enable the development of a federation of service providers, by interconnecting the computing resources in a way that they can communicate with each other; and (ii) will manage providers' access to, and the availability of edges. The software shall also ensure that this environment will be highly scalable, trustworthy, as well as complying with data protection and environmental rules.

(10) Edge computing describes a decentralised approach to execute certain digital services closer to the devices where data is generated, via distributed hardware resources. It supplements centralised cloud computing solutions (such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)) by collecting and processing data locally. In this way, the unnecessary transmission of data over the network is minimised and the overall performance of data processing is improved. Edges do not necessarily need to belong to a cloud provider. There are several market actors able to offer these services, for instance telecom operators and providers of internet of things (IoT) solutions. The integration of cloud computing services with data processing hardware resources deployed at the edge by diverse types of providers will enable the realisation of a computing continuum. The latter is a concept that consolidates distributed network, computational, and storage resources from a range of data processing infrastructure services providers. The basis for a cloud to edge continuum is the provision of software services operated in a data centre ([10]). Data centres are infrastructures that offer data processing services thanks to the use of virtualisation and can be interconnected. Their integration means they can communicate which each other through interfaces ([11]).

(11) The technological infrastructure, where all the above actions take place, consists of networks built around the core internet technologies, as designed in the 1980s and 1990s. Hence, they have limited technical capabilities. To mitigate this limitation, physical and virtual solutions have been developed to optimise the flow of information outside of the respective network. However, these solutions are largely proprietary, often controlled by single companies and operating on the basis of their own software, without interacting with each other, as depicted in the left-hand side of Figure 1. In contrast, the Multi Provider Cloud Edge Continuum will provide for interconnection and seamless operation of the cloud and edge components, even if they are operated by independent providers, as depicted on the right-hand side of Figure 1. This difference is visualised in the following figure:

([10]) A data centre is a set of physical machines, which provides remote data processing infrastructure, comprising of access to a network, room for storage and servers.

([11]) An interface is software that allows for the exchange of data of different servers, which may be physically in different locations.

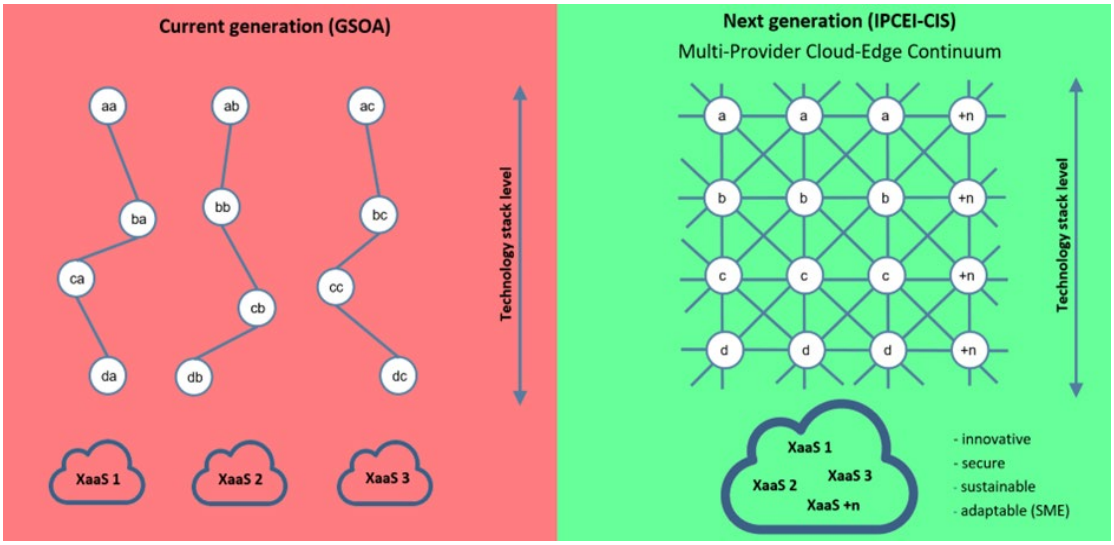

Figure 1 – Visualisation of current proprietary technologies vs multi provider cloud edge continuum

(12) To achieve a functioning Multi Provider Cloud Edge Continuum all components must work in unison even though they are operated by many independent entities, e.g. operators of networks and internet exchanges, internet service providers and telecommunication companies, hosting services, cloud and edge providers, or providers of advanced services and applications and their users.

(13) Central to solving this challenge are the interfaces between the different components, which are essentially software that enables the communication between different operators. Interfaces can be proprietary (as done by some market actors) or can be based on open-source specifications, allowing a wider community agreement for mechanisms to access and operate the Multi Provider Cloud Edge Continuum together ([12]). To facilitate the establishment and access to interoperable interfaces, IPCEI CIS will develop an open reference architecture, which is similar to a standard, but which is not based on a certain procedure and can be implemented within a shorter timeframe. Such reference architecture can be instantiated by multiple providers independently and can be implemented across multiple systems. This will allow for uniform abstraction layers ([13]) ensuring interoperability between different solutions by adhering to the agreed upon interface structure. This abstraction layer can be part of a software package (the so-called technology stack) which will enable users to access different components on the architecture by different market actors.

(14) The different market actors will further bundle certain functionalities into services collectively referred to as XaaS ("Anything as a Service"), which will utilise the common interface structure. These data processing services provide additional building blocks of the software package, i.e. the technology stack that forms the

([12]) Open-source software is software that is publicly available, and its source code can be inspected, modified and enhanced by any user, under the caveats stemming from the licenses covering the original software. By contrast, proprietary software is not publicly available and is not modifiable.

([13]) An abstraction layer hides the underlying implementation details and complexity of a functionality, component, system or another layer and exposes only an interface with whom other elements can communicate.

basis of the Multi Provider Cloud Edge Continuum. These additional services can be based on either open-source or proprietary software.

(15) Against this backdrop, the Member States intend to grant State aid to undertakings that will participate in IPCEI CIS, in order to develop software for an open, accessible, innovative and sustainable Multi Provider Cloud Edge Continuum, which will go substantially beyond the global state-of-the-art. IPCEI CIS will bring together undertakings working at different levels of the cloud edge computing continuum.

2.2. Objectives of IPCEI CIS

(16) In the Chapeau document, the Member States submit that IPCEI CIS aims to perform research, development and innovation (R&D&I) and first industrial deployment (FID) of the software components necessary to establish and operate a distributed, openly accessible and interoperable EU Multi Provider Cloud Edge Continuum, thus supporting Europe's digital transformation. This overall objective is further translated into the following four specific objectives:

(a) developing means for enabling the management of data processing services and secure and reliable operations between networks that meet the requirements of advanced cloud and edge applications;

(b) developing a common reference architecture that provides a blueprint for how to set up and run an interoperable cloud and edge system;

(c) developing a set of advanced cloud and edge services that can be deployed seamlessly across providers and are designed to be reusable in various application contexts;

(d) developing selected, feature complete applications to serve as proof of concepts that test and validate the successful implementation of the Multi Provider Cloud Edge Continuum.

2.3. Focus and description of IPCEI CIS

2.3.1. Focus and purpose of IPCEI CIS

(17) The Member States submit that the activities performed in the framework of IPCEI CIS qualify as R&D&I and FID in the meaning of points 22 to 24 of the IPCEI Communication.

(18) On the basis of the information contained in the individual project portfolios, the Member States submit that the nature and scope of the R&D&I projects falling within each of the workstreams ("WS") covered by IPCEI CIS are such that those projects are of a major innovative nature or constitute important added value in terms of R&D&I in light of the state-of-the-art in the cloud and edge computing sector. Furthermore, the Member States submit that the FID projects will enable the development of new products or services with high R&D&I content or the deployment of fundamentally innovative cloud and edge services, going beyond mere upgrades of existing capabilities without an innovative dimension or the development of newer versions of existing products. According to the Member States, aid granted under IPCEI CIS is limited to R&D&I and FID projects and does not cover commercial sales, nor does it extend to the mass production phase

of any of the products, services or processes resulting from the individual projects.

(19) Moreover, the Member States submit that this IPCEI aims to overcome important market and societal failures in line with point 3 of the IPCEI Communication. With the coordinated and simultaneous nature of the IPCEI, a large majority of projects addresses at least coordination failures, while several projects address also positive externalities due to their open-source nature or negative environmental externalities (see also section 3.3.2.2.2). In addition, the Member States also provided evidence that the projects comply with the do no significant harm principle (see also section 3.3.2.2.7) pursuant to point 20 of the IPCEI Communication.

2.3.2. Description of the WS in IPCEI CIS

(20) The Member States explain that IPCEI CIS is organised along four different WS, each of which represents a layer of technologies and capabilities required for the completion of the Multi Provider Cloud Edge Continuum. Within each of these WS, the participating undertakings will conduct both R&D&I and FID activities.

(21) The Member States describe that the various outputs of the four WS collectively contribute to the technological, operational, and organisational capabilities needed to create a Multi Provider Cloud Edge Continuum.

(22) The four WS are designed so that each one builds upon the other. WS 1 concerns the advances at the level of infrastructure resources, by laying down the necessary methodologies, and physical infrastructure requirements to enable the operation of cloud and edge components. WS 2 focuses on building the open common reference architecture for the operation and management of a federated, interoperable cloud edge systems. WS 3 comprises the development of general, horizontal advanced cloud and edge services that can be deployed seamlessly across diverse providers. WS 4 goes one step further by providing complete applications for sector-specific use cases, which can provide domain-specific solutions and serve as proof of concept.

2.3.2.1. WS 1 – Cloud Edge Continuum Infrastructure

(23) WS 1 is devoted to the infrastructure resources readiness ([14]) in order to take part in the deployment and operation of the Cloud Edge Continuum. Such infrastructure is both tangible (hardware) and intangible (software). Hardware infrastructure refers to the physical facilities (e.g. edge nodes), as well as hardware-related technologies, which need to be adapted in order to enable the federation, i.e. the interconnection of different processing facilities from different providers and in some cases to improve energy efficiency. Software infrastructure refers to programmatically enable advanced interconnection of networks, namely, on the one hand, the connection of nodes with each other along the continuum, and on the other hand the connection of nodes with the users. Such integration will ensure that the required level of quality of various parameters such as latency and service continuity as well as a high level of cybersecurity is attained.

([14]) In other words, WS 1 will develop software, such as interfaces, which ensures that existing infrastructure can be ready for and compatible with the innovative technologies to be developed within this IPCEI.

(24) The overarching objective of WS 1 is to provide software developing all necessary infrastructure-related capabilities to build the base layers of the edge cloud stack, such as resource availability and management, energy monitoring, security, performance metrics and network connectivity determination.

(25) The participating undertakings will contribute to WS 1 with various R&D&I and FID activities. The relevant activities include: developing interconnected and interoperable facilities, providing the technological basis for time-critical data computing (ultra-low latency), as well as for AI/ML ([15]) services. This shall ensure real-time data processing and storage and shall be based on a standard and open Application Programme Interface (API) ecosystem ([16]).

(26) The abovementioned activities are expected to contribute to the following main specific objectives:

(a) providing a "base layer" of technical possibilities, which will enable integrated and interoperable facilities management and automated orchestration;

(b) enabling faster and reliable data processing;

(c) increasing interoperability between different software ecosystems;

(d) ensuring a high level of cybersecurity, data transparency and control in the solutions offered;

(e) reducing the carbon footprint of data processing locations (e.g. edge nodes).

(27) The projects included in WS 1 face multiple challenges. Since the Multi Provider Cloud Edge Continuum will be available also to existing data processing facilities, the standard and open API solutions must be compatible with or adaptable to existing hardware and software (so-called "backward compatibility"). In order to be interoperable across different providers, they need to achieve a high degree of automation and availability across the network. Similarly, horizontal aspects such as security and energy efficiency also need to be designed and provided as widely applicable and available to all users.

2.3.2.2. WS 2 – Cloud Edge Capabilities

(28) Building on top of the lower layer of infrastructure resource readiness provided by WS 1, WS 2 aims to develop a common reference architecture which will serve as a blueprint for how to set up and operate a cloud and edge system. That architecture will be the cornerstone of the Multi Provider Cloud Edge Continuum, as it will provide its essential software layer, which will enable the necessary services and possibilities at its operating level.

([15]) Artificial Intelligence (AI) and Machine Learning (ML).

([16]) An API, or Application Programming Interface, provides an abstraction of the underlying implementation of a problem through a set of defined protocols and definitions. APIs hide the implementation details of how the application works but developers can expose those parts of their applications that need to interact with other components, services or third-party applications. APIs foster interoperability amongst systems and services thanks to this open and common specification.

(29) The overarching objective of WS 2 is to design and provide an innovative and holistic reference architecture, which will enable the implementation and operation of the Multi Provider Cloud Edge Continuum. This Cloud Edge Continuum will offer services such as: federation, i.e. logical interconnection of resources and meta-orchestration, i.e. the linking of the aggregated resources in a seamless manner. To achieve this objective, the different resources need to be structured and made accessible as a service commonly referred to as XaaS. These services will be accompanied by monitoring and optimisation possibilities.

(30) The participating undertakings will contribute to the WS 2 with R&D&I and FID activities aiming to develop novel methods and capabilities for network and resource management (allocation, failure detection and recovery), user management (identification, detection of access rights, data protection and privacy), scalability and cybersecurity; all these features must be mature, available and operating successfully across provider boundaries, as well as across target systems (e.g. small IoT edge devices or large computer clusters in data centre).

(31) The development of a common reference architecture in WS 2 encounters several challenges. Such challenges are twofold: on the one hand, they pertain to the specificities of the respective processing environment (i.e. near edge, far edge ([17]) or cloud), as the resulting reference architecture needs to adapt and address the particular needs of each environment; on the other hand, they relate to the need to establish cross-cutting features and processes ensuring seamless integration and operation for all target systems (e.g. latency, automation, security). In other words, the common reference architecture needs to be both flexible and individually adaptable, as well as uniform and widely applicable.

2.3.2.3. WS 3 – Advanced Smart Data Processing Tools and Services

(32) Following the development of the necessary infrastructure resource readiness (WS 1) and the development of a common reference architecture (WS 2), this WS aims to develop a set of advanced cloud and edge services that can be deployed seamlessly across networks of providers. This will be achieved through the design of services that are reusable in various application contexts as building blocks for cross-domain service integration. WS 3 will help overcome highly ecosystem-specific concepts, where – among others – data is only transferable to other environments with substantial efforts.

(33) To this end, the overarching objective of WS 3 is to define and build ready to use, fully configurable and modular processing services to create, operate, and maintain applications and services in all IPCEI CIS application domains. The development of those applications targets the applicability across cloud and edge data processing facilities. These advanced processing services are indispensable for the adoption of cloud-edge based solutions.

([17]) Near edge refers to edge facilities deployed between the far edge nodes and the cloud data centres. These are characterized by a power capacity of up to 1 MW and a latency of <10ms. Far edge refers to far edge facilities facilities deployed on a location furthest from the cloud data centre characterized by a power capacity of up to 200 kW and a latency of <5ms.

(34) The participating undertakings will contribute to WS 3 with R&D&I and FID activities for the development of the way data and knowledge is shared on the Multi Provider Cloud Edge Continuum (e.g., description, transformation, exchange, storage and retrieval of data in a secured, compliant and efficient way), the use of AI to enable new services (as improving ecosystem analytics and optimization end user experience), the life cycle management of the processing services, the multi-cloud composition of services (management tools to integrate several applications/services together for the automation of a process or synchronisation of data), and the way the ecosystem of processing services is organised and coordinated.

(35) In order to achieve WS 3's overarching objectives, the projects in this WS address diverse challenges. In contrast to the current global state of the art, a Multi Provider Edge Cloud Continuum requires applications running on a variety of hardware and software environments from heterogeneous vendors. This includes unified access methods to data distributed across diverse environments, which is challenging in terms of security, speed, simplification and harmonisation (e.g. fast and trusted data exchange, simplified communication services, real-time processing, standard data models).

2.3.2.4. WS 4 – Advanced Applications

(36) WS 4 aims at finding solutions for complex real life, sector-specific cases so as to demonstrate the maturity of the Multi Provider Cloud Edge Continuum solutions developed in WS1 to WS 3. WS 4 demonstrate that specific use cases in economic sectors such as energy, health, and manufacturing can gain benefits by being integrated in the Continuum and that these results can be transferred to other sectors. The overall objective of WS 4 is to identify and overcome R&D&I challenges regarding integration and the operation of complex applications within the Multi Provider Cloud Edge Continuum as well as R&D&I challenges regarding the transferability of sector-specific solutions to other sectors.

(37) To this end, the participating undertakings will contribute to the WS 4 with R&D&I and FID activities aiming at the successful integration and operation of complex industrial applications that run on the Multi Provider Cloud Edge Continuum employing solutions enabled by WS 1, 2 and 3. These activities are expected to support the following main innovations and corresponding milestones:

(a) Closing the gap between the cloud edge information technology (IT) domain and the industrial operational technology (OT) domain regarding integration and operation of complex industrial applications;

(b) extension of the digital twin paradigm to become a key mechanism to achieve transferability of sector-specific solutions;

(c) data ownership and data security (e.g. unlock data silos by ensuring security, interoperability and portability);

(d) enabling distributed AI in the multi provider cloud edge continuum.

(38) To meet the above objectives and contribute to the development of the Multi Provider Cloud Edge Continuum, the WS 4 has several challenges to tackle. The

main challenge addressed in this WS is to overcome today's need for hand-crafted, highly custom solutions regarding the integration and operation of complex cloud and edge applications. Typically, such custom solutions depend heavily on the specific circumstances of the respective area or industrial sector. Often this leads to technical lock-ins, poor interoperability and transferability of developed components.

(39) Furthermore, WS 4 aims to identify and develop solutions for challenges regarding the transferability of sector-specific solutions to other sectors and the agile exchange of requirements for specific system components including their validation in realistic applications.

2.3.3. Description of the participating undertakings in IPCEI-CIS

(40) This section briefly describes the 19 direct participants involved in the four different WS of the IPCEI CIS. The individual projects of each direct participant under the different WS are described in more detail under sections 2.5.1 to 2.5.4.

(41) The participating undertakings, including 3 SMEs, are:

Arsys Internet S.L.U. ("Arsys")

(42) Arsys (Spain) is part of the Ionos group. It offers internet presence services, cloud computing and IT infrastructure solutions, while also managing data centres and edge nodes. It specialises in fully customised cloud projects (e.g. public, private and hybrid cloud, backup and security).

Atende Industries sp. z o.o. ("Atende")

(43) Atende (Poland) provides cloud platforms and SaaS ("Software as a Service") solutions, with a particular focus on the energy and industry sectors, offering smart grid and Industry 4.0 solutions, respectively.

Atos SE ("Atos")

(44) Atos (France) is part of the Atos group and offers end-to-end solutions for cloud, big data, business applications and digital workplace. It serves a wide variety of sectors, such as finance, health, manufacturing, media, retail, telecommunications and transport.

CloudFerro S.A. ("CloudFerro")

(45) CloudFerro (Poland) is an SME that provides cloud computing services in public, hybrid and private modes using open-source software solutions. The company delivers and operates cloud computing platforms dedicated to specific domains and industries such as the European space sector, climate research and science.

Deutsche Telekom AG ("DTAG")

(46) Deutsche Telekom (Germany) belongs to the Deutsche Telekom Group, a telecommunication company. It provides fixed network/broadband and mobile communications, as well as internet and internet protocol television (IPTV) products, serving both individual and corporate consumers.

E-Group ICT Software Zrt. ("E-Group")

(47) E-Group (Hungary) is an SME that offers products in the areas of innovative data management and integration, data analytics, data security, cryptographic and transactional solutions for various industries.

Engineering Ingegneria Informatica S.p.A. ("Engineering")

(48) Engineering (Italy) produces IT innovation for its clients with a complete offer combining system and business integration, outsourcing, cloud services, consulting, and proprietary software solutions.

Fincantieri S.p.A. ("Fincantieri")

(49) Fincantieri (Italy) belongs to the Fincantieri group, which focuses on ship building, but also offers products and services in various fields such as electronics, advanced systems, Integrated Logistics Support, IT and cybersecurity applied to the maritime sector, along with other transversal activities.

4iG Plc. ("4iG")

(50) 4iG (Hungary) is a broad-spectrum solution provider that is engaged in IT, telecommunications, telecom satellites and telecom infrastructure development, UAV technologies, integrated ERP tand process management systems, as well as data-centre building and operation ([18]).

Leaseweb Global B.V. ("Leaseweb")

(51) Leaseweb (Netherlands) provides business-to-business services in the area of Cloud and IaaS. It mainly focuses on hybrid cloud, by offering services such as "bare metal cloud", elastic cloud, private cloud, cloud storage and colocation ([19]).

Oktawave S.A. ("Oktawave")

(52) Oktawave (Poland) operates its own cloud infrastructure platform through numerous virtual servers and providing IaaS services mainly to the sector of e-commerce, but also to financial and government institutions.

OpenNebula Systems S.L. ("OpenNebula")

(53) OpenNebula (Spain) is an SME that currently offers an open-source cloud and edge computing platform, the only open-source orchestrations technology developed in Europe. It provides support for virtual machines and application containers, as well as cloud and edge infrastructure resources for to build private, public and multi-provider clouds.

([18]) UAV (unmanned aerial vehicle) technologies and ERP (enterprise resource planning) are explained in Annex III – Glossary of technical terms.

([19]) Bare metal cloud, elastic cloud, private cloud, cloud storage and colocation are explained in Annex III – Glossary of technical terms.

Orange S.A. (“Orange”)

(54) Orange (France) is part of the Orange group, a telecommunications operator. Its main focus is mobile and fixed broadband services for private customers, while it also engages in global IT and cloud services to corporate clients.

Reply S.p.A. (“Reply”)

(55) Reply (Italy) specialises in digital services, systems integration and consulting. Reply is engaged in AI, big data, cloud computing and IoT by serving a wide range of customers, such as media, industry, energy and public administration.

SAP SE (“SAP”)

(56) SAP (Germany) develops and provides software solutions for businesses, such as standard applications, industry solutions and platforms, which for instance may process data or forecast customer satisfaction. Among these solutions, SAP also provides cloud services, covering a wide customer portfolio.

Siemens AG (“Siemens”)

(57) Siemens (Germany) is a technology company focused on industry, infrastructure, transport, and healthcare and provides industrial companies with consistent solutions and services for the integration and digitalization of the entire value chain.

Telefónica España S.A. (“Telefónica”)

(58) Telefónica (Spain) is an established telecommunications provider, offering landline, broadband and digital television services. It is also active in the cloud market, by offering (among others) IaaS and PaaS, colocation and virtual cloud services.

TIM S.p.A. (“TIM”)

(59) TIM (Italy) forms part of the TIM group, an established telecommunications provider. It develops fixed, mobile and cloud infrastructures and data centres. It offers communications and entertainment services and products, including digital solutions in the cloud, IoT and cybersecurity sectors.

Tiscali Italia S.p.A. (“Tiscali”)

(60) Tiscali (Italy) is a smart telco company, that provides retail, Business and Public Administration connectivity, cloud and digital services, focusing on FWA (Fixed Wireless Access) and FTTH (Fiber To The Home) as well as integrated mobile services.

(61) Furthermore, the IPCEI CIS involves 90 indirect partners, including 35 SMEs, 5 Start-ups, and 20 ROs, which contribute to the IPCEI ecosystem. According to the criteria agreed by the Member States in the Chapeau document, these indirect partners underwent a national selection process for IPCEI CIS and were selected by their Member State according to its specific selection criteria. They took part in the design of IPCEI CIS (e.g. by participating in the matchmaking process); they have effective cross-border collaboration with at least one direct participant or one other indirect partner; they are members of the General assembly of IPCEI

CIS with voting rights. The indirect partners may receive funding, which has not been notified in this context to the Commission and such funding is neither being examined nor approved in the context of this decision. Instead, the indirect partners have been identified by their funding Member States and on this basis are listed in Annex II to this decision. Additional Member States that have submitted indirect partners to IPCEI CIS are Belgium, Croatia, Latvia, Luxembourg and Slovenia.

2.4. Governance of IPCEI-CIS

(62) A governance structure will be set up for the implementation and monitoring of IPCEI CIS. The Member States commit to this governance structure and will contribute to it with alignment of their national strategies and with the development of innovative technologies along the cloud edge value chain. This structure is summarized in the figure below:

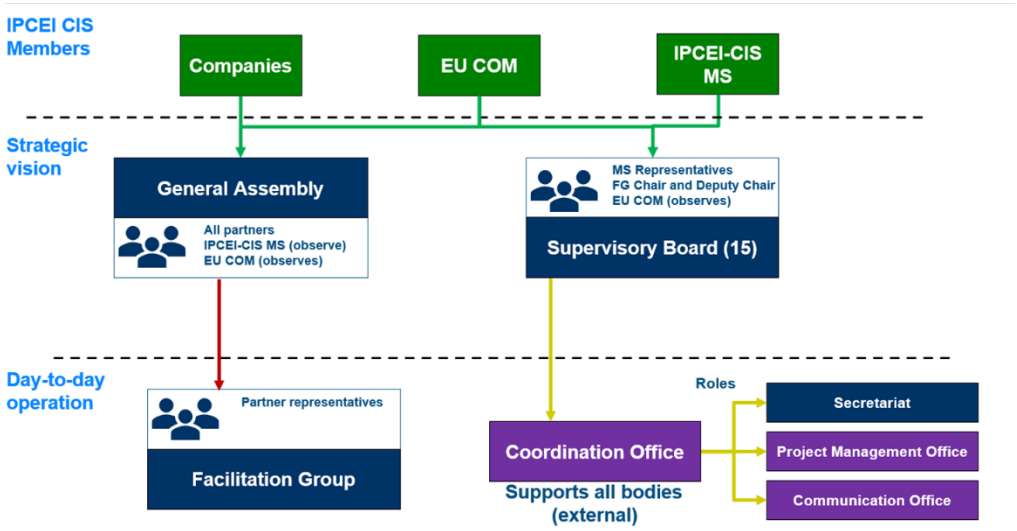

Figure 2 - IPCEI CIS governance structure

(63) The IPCEI CIS General Assembly ("GA") consists of:

(a) All partners to the IPCEI (direct participants and indirect partners),

(b) representatives of all Member States participating in the ecosystem of IPCEI CIS (with direct participants or indirect partners), acting as observers and without voting rights,

(c) the Commission, acting as an observer and without voting rights.

(64) The IPCEI CIS Supervisory Board ("SB") consists of:

(d) The Member States participating in the integrated project (with direct participants or indirect partners). Each Member State has one vote.

(e) The IPCEI CIS Facilitation Group ("FG"), which consists of members elected from the GA, with the aim to represent the GA's partner members in the SB. The FG is represented in the SB meetings by its Chair and Vice Chair and has two votes.

(f) One representative of the Commission, as permanent observer and without voting rights.

(g) The Head of the Coordination Office ("CO") as permanent observer without voting rights.

(65) The GA is a forum for exchange and discussion for all IPCEI partners, Member States and the Commission. It will be organised at least once a year. At its first meeting, within two months after the Commission's decision approving IPCEI CIS (which can take place virtually), the GA will establish the governance structure and will elect the Chair and Vice Chair of the FG, as well as the Chair and Deputy of the coordinators of each workstream, who will be members of the SB. During the GA, the SB will present its strategy for IPCEI CIS, as well as an overview of the progress of the integrated project.

(66) The role of the SB will be to supervise, monitor and ensure the implementation of IPCEI CIS at large. This concerns, in particular, the monitoring of the progress of the participating undertakings' individual projects, as well as of IPCEI CIS as a whole. In this context, the SB will be responsible for the annual reporting to the Commission on the basis of information provided by the FG and by the CO. Moreover, the SB will provide strategic guidance on the master project plan and on decisions regarding technological issues and alignment with standards. It will also be responsible to resolve disputes among the IPCEI participants. The decisions of the SB will be binding towards all participants of IPCEI CIS. In principle, the SB will meet twice a year. In addition, the SB may meet in extraordinary session to discuss any event relating to IPCEI CIS, such as remedies in case of delays in the implementation of the integrated project.

(67) The IPCEI CIS FG consists of ten representatives of all IPCEI CIS partners. The Chair and Vice Chair will be elected by the GA. Eight coordinators will be elected within the four workstreams, namely two coordinators per workstream. The FG's main duty is to serve as a permanent communication channel between the IPCEI CIS partners, on the one hand, and governing bodies, on the other. Apart from that, the FG will be responsible to monitor the results of the individual projects, including the dissemination and spillovers, sustainability and security impacts; it will also report to the GA and SB.

(68) The CO is a permanent office that acts as the overall coordination, project management and communication office on behalf of the SB on a day-to-day basis. It handles operations, management, reporting, internal and external communication activities. The exact scope of the CO's duties will be further refined by the SB on the basis of its needs.

(69) As regards national governance, the participating undertakings' individual projects are governed by funding agreements to be concluded with the relevant funding authority within each Member State. Such funding agreements impose requirements and obligations towards the administration of any individual project according to the rules set up by the funding authority. The national funding authorities are in possession of the commitments of all participating undertakings. As such, the Member States will be responsible for monitoring the completion of the respective partners' project commitments, e.g. deliverables, sustainability, do no significant harm principle, as well as the committed spillover activities and knowledge dissemination. The structure of national governance shall be designed

in a manner adequate to address all IPCEI-related responsibilities and obligations of the participating Member States.

(70) A website dedicated to IPCEI CIS will be created. It will consist of a public area, which will provide information about the integrated project to the wide public, and of a restricted members' area. The latter will serve for the IPCEI participants to organise the implementation of IPCEI CIS, by planning their individual projects, sharing non-public information, using a project planning tool, uploading deliverables and other relevant information. Through this website, the FG and CO will collect qualitative and quantitative information necessary to fulfil the monitoring and reporting obligations. The website will be hosted by an IPCEI CIS partner, group of partners or Member States; a dedicated agreement will clarify that the website will belong to the IPCEI CIS Member States (through their respective Ministries).

2.5. IPCEI CIS as an Integrated Project

(71) The Member States submit that IPCEI CIS is an integrated project within the meaning of point 13 of the IPCEI Communication. The Member States explain that IPCEI CIS is based on a common programme aiming at the same objectives and is based on a coherent systemic approach, as laid down in the common Chapeau document.

(72) The Member States also explain that the four WS of IPCEI CIS, as well as the respective individual projects of the participating undertakings, are both complementary and significantly add value in order to meet the objective of each WS separately and of IPCEI CIS as a whole. The figure below presents the overall structure of IPCEI CIS, including the individual projects by the participating undertakings in the four WS:

Figure 3 - Overall structure of IPCEI CIS

(73) The individual projects of the participating undertakings are outlined below in the four WS. In order to facilitate attaining the common objectives, the research activities taking place within each WS are grouped into key research areas, each of which being necessary to achieve the individual results within the relevant WS.

2.5.1. Significant added value and complementarity of the individual projects for the achievement of the goals of WS 1

(74) WS 1 involves two participating undertakings: DTAG and Telefónica.

(75) The individual projects of the participating undertakings will contribute to this WS through the development of innovative solutions in order to render the hardware and software infrastructure resources prepared for and able to support their integration in the Multi Provider Cloud Edge Continuum. Such infrastructure resources will enable the integration of various types of data processing facilities (both existing and future), across providers, as well as across Member States.

(76) More specifically, the R&D&I and FID activities of WS 1 can be grouped in six key areas of research: (a) interconnection and federation of distributed data processing resources, (b) multi-provider quality of service (QoS) guarantees and placement of data processing workloads ([20]), (c) open reference designs and implementation in edge and data facilities, (d) unified security across providers, (e) sustainability of distributed data processing resources, and (f) availability and accessibility of the developed solutions.

(77) Key research areas (a), interconnection and federation of the distributed data processing resources, and (b), multi-provider QoS guarantees and placement of data processing workloads, concern the integration of different data processing locations (central cloud, near edge or far edge ([21])). The different data processing locations need to be prepared for the connection with each other; such connection needs to enable the placement of workloads based on specific QoS necessities (e.g., latencies, bitrates, security and availability guarantees). To this end, the development of open and standard APIs is also required, which will ensure an open and equal third-party access to the capabilities. The respective R&D&I and FID phases of key research areas (a) and (b) contain the following indicative activities ([22]):

- exploring technological solutions and new interfaces that would enable the integration of pre-existing data processing facilities in the Multi Provider Cloud Edge Continuum, including the integration of Network as a Service (NaaS) concepts;

([20]) Workload placement strategies are techniques and processes used to identify the best location and combination of resources to run an application (workload), taking into consideration the requirements of the application and the properties of infrastructures and their resources.

([21]) Examples of such locations in the IPCEI ecosystem might be: renewable energy plants, railway stations, telecommunications central offices, cell tower sites, etc.

([22]) The Commission has assessed all the notified R&D&I and FID activities and tasks that are included in the key research areas of each WS and are part of the participating undertakings' individual project(s). For reasons of brevity and efficiency, the decision provides only some indicative references. This statement is valid for the respective descriptions in all WS.

- developing new methods for joint high-performance computing as a service to enable the integration of multiple edge and cloud facilities;

- specifying and coordinating minimum and optional interface requirements, which would enable the use and management of various services from a single system;

- designing proof of concepts for new specialised hardware concepts (e.g. servers), which will support heterogeneous data processing services;

- exploring technical solution that will enable joint monitoring and management of the federated cloud and edge resources;

- developing innovative ways of joint high-performance computing (HPC / bare metal) as a service, to enable fast and seamless integration of multiple edges and cloud facilities into the Continuum;

- developing the novel network APIs to ensure the interconnection of networks and the integration of edge solutions in mobile and fixed networks across regions and operators.

(78) Key research areas (c), uniform open and reference designs and implementations, concerns open and standard configurations for edge and data facilities. It aims at supporting economies of scale and collaboration in the design of novel processing facilities and resources at the infrastructure layer which will ultimately result in comparable and consistent quality of experience across providers. The R&D&I achieved through these activities will be tested in laboratories and innovation centres. The R&D&I and FID phases of key research area (c) contain the following indicative activities:

- exploring technical solutions for the design and configuration of decentralised processing facilities and resources, specifically tailored for the needs of Telco Cloud and their integration into the Cloud to Edge Continuum;

- creating de facto standards and guidelines for defining innovative processing facilities, infrastructures, and resources so that providers can provide a uniform service experience.

(79) Key research areas (d) cybersecurity, (e) sustainability, as well as (f) availability and accessibility concern wide-ranging aspects, necessary to ensure high quality of services in all components of WS 1. These aspects concern, respectively: cybersecurity and data protection; energy efficiency; wide availability and easy use of the tools and services developed across the Continuum. They also encompass the development of solutions for open reference implementations, thus enhancing accessibility and availability of these implementations. These three key research areas also comprise specific FID phases, to gain knowledge and experience in the implementation and operation of the results of this WS. This includes, among others, FID of green, secure and open cloud and edge facilities, and testing in realistic and heterogeneous use cases ([23]) settings, i.e. in various

([23]) Use cases are the real-life application scenarios, where the software is tested in the course of its development. In most projects, the performance of use cases takes place in the FID phase.

real-life scenarios and sectors, as well as in testing and validation centres. The R&D&I and FID phases of these deliverable tasks contain the following indicative tasks:

- defining and developing novel multi-provider security mechanisms, applicable across provider boundaries that will also serve as de facto standards;
- preparing newly defined interfaces and mechanisms for energy efficiency and CO_2 footprint reduction;
- developing and ensuring the availability of the necessary testing environments;
- ensuring that the testing processes are reliable, while also maintaining the continuous interoperability of the federated system.

Description related to the significant added value of the individual projects

DTAG

(80) The project of DTAG aims to develop and test advanced edge applications across regions and operators focusing on the network integration. It will advance the interconnection of distributed data processing resources through leveraging network APIs for edge integration solutions in mobile and fixed networks across regions and operators. The project will also enable the implementation of multi provider QoS guarantees by developing workload prioritisation capabilities that facilitate cross-border solutions. Furthermore, it will work on unified cybersecurity across providers by developing solutions that focus on edge security, and it will contribute to the significant improvement of sustainability of distributed data processing resources by developing energy efficiency solutions that focus on edge node efficiency. The features developed by DTAG will also guarantee the availability and accessibility of its solutions.

Telefónica

(81) The project of Telefónica focuses on near edge data processing and interconnection. It advances the scalability of data processing workloads by developing solutions for the scalability of edge computing use cases in near edge settings including applications that require ultra-low latency. This also contributes to the implementation of multi provider QoS guarantees on ultra-low latency in the near edge setting. It further contributes to the significant improvement of sustainability of distributed data processing resources by developing solutions to improve the energy efficiency in the near edge setting. Lastly, it contributes to ensuring the availability and accessibility of the developed solutions by developing prototypes and modular blueprint for edge nodes in regional data processing facilities. Overall, Telefónica's aim is to set a uniform reference design, thus ensuring consistent quality of service to its users.

Description related to the complementarity of the individual projects

(82) According to the Member States, the individual projects in WS 1 are complementary because they offer solutions for different, heterogeneous requirements, while still striving towards the same wider objective, which is to

make available a unified interconnection layer of data processing facilities. In order to provide for a unified interconnection layer, DTAG focuses on far edge integration into the network, data prioritisation and security, while Telefónica focuses on near edge computing comprising various aspects such as latency and energy efficiency. In addition, the undertakings work on the integration of cross-cutting aspects, such as sustainability, security and availability of the developed solutions. In light of the main objective of WS 1, close cooperation and the establishment of synergies between the different projects is an integral and indispensable part of this workstream.

(83) Figure 4 illustrates the main contributions of the individual projects to the key research areas, based on the significant added value they bring to WS 1, as described in this Section:

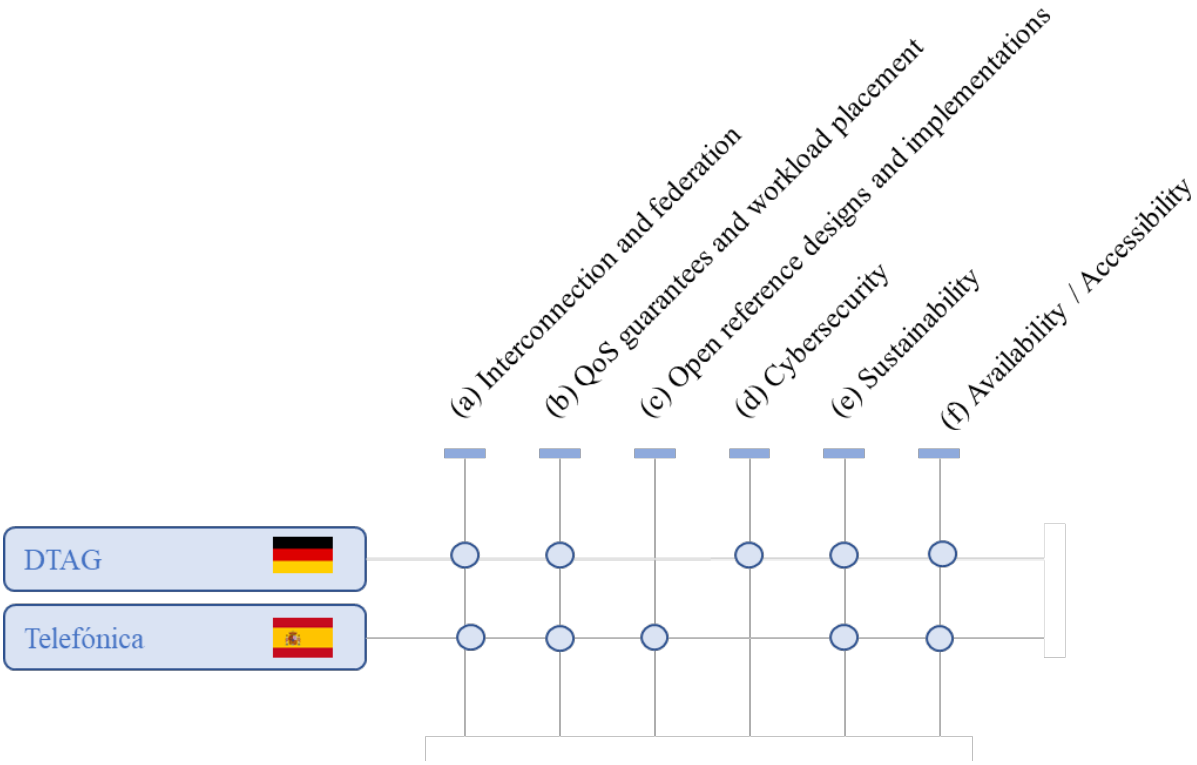

Figure 4 - Main contributions of individual projects in WS 1

(84) The complementary character of the individual projects is illustrated by the collaboration between DTAG and Telefónica, within WS 1, as explained in section 2.5.6.1.

2.5.2. Significant added value and complementarity of the individual projects for the achievement of the goals of WS 2

(85) WS 2 involves 10 participating undertakings, namely Arsys, Atende, Atos, Leaseweb, Oktawave, Open Nebula, Orange, Reply, SAP, TIM.

(86) WS 2 will develop the basic software layer for the Multi Provider Cloud Edge Continuum. In order to achieve true interoperability across providers, the objective of WS 2 is to build an abstraction layer that makes its technological capabilities available to all data processing services and applications in a scalable and seamless manner. Through streamlining and organising the procedures

involved, WS 2 lowers the barrier for providers to enter the Multi Provider Cloud Edge Continuum.

(87) The R&D&I and FID activities of WS 2 can be grouped into six key research areas: (a) distributed and federated life cycle management, (b) distributed and federated data and network management, (c) distributed and federated workload management, (d) availability and accessibility, (e) cybersecurity and (f) sustainability.

(88) Key research area (a), distributed and federated life cycle management, relates to the activities necessary to develop the main data processing operations. It includes the federation and meta-orchestration of resources coming from different cloud and edge providers and involves managing resources of many kinds, such as those related to processing, data and network. Federation is the process of linking the resources of multiple providers in a decentralised manner. Meta-orchestration is the process of aggregating these resources in a way that they can be used seamlessly. These two activities are crucial to enable data processing and management capabilities, in a uniform and reliable manner. In addition, life cycle management includes capabilities related to system monitoring, management and optimisation. The R&D&I and FID phases relating to distributed and federated life cycle management contain the following indicative activities:

- developing tools and associated methodologies for the life cycle management of services provided across different providers, such as applications for resource allocation, distribution of workload, migration and updates of applications;

- exploring tools for access and identity management, access rights, billing solutions, while also ensuring privacy and compliance with the relevant regulations;

- optimising service monitoring, by providing for tools for failure detection and recovery.

(89) Key research area (b), distributed and federated data and network management, includes the creation of a "XaaS" layer, namely the grouping and structuring of different resources (coming from different providers) as well as the process of making them available through one single bundle of services (the so-called "anything-as-a-service"). Moreover, it comprises software-based network resource management and operation. This set of services, in turn, require operating systems and accompanying virtualisation technologies, which overcome the inherent complexity in the underlying, heterogeneous systems (ranging from small edge devices to large cloud servers and taking into consideration the diverse nature of the managed resources). The development of these operating systems and virtualisation services falls under this research area. The respective R&D&I and FID phases relating to federated and distributed data management contain the following indicative activities:

- exploring and developing new methods for network, data and identity management across provider boundaries;

- developing software and communication protocols so that all types of devices (e.g. including small IoT devices) can be integrated into the Cloud Edge Continuum;

- exploring technologies to ensure scalability of the deployment models across different providers.

(90) Key research area (c), distributed and federated workload management, is fundamentally based upon integration, management, monitoring and optimisation. While monitoring assesses the status of resources and workloads, optimisation maps the current workloads onto the available resources and then assigns such workloads to the most appropriate resources, based on the optimisation algorithm result. A high degree of automation is particularly important throughout all these operations to ensure a seamless, quick and reliable processing. Apart from these, workload management includes capabilities related to portability and interoperability, as it requires the linking of workload among providers. It also includes capabilities relating to the operating system and virtualisation, which are necessary to make the workload management available, easily usable and extendable to cover a wide range of devices. The R&D&I and FID phases relating to distributed and federated workload management contain the following indicative activities:

- exploring algorithms and solutions for resource allocation and management, as well as optimised distribution of workload;

- developing technologies for compute orchestration among diverse edge and cloud technologies and providers;

- optimising software and communication protocols in order to allow small IoT devices to be integrated into the Cloud Edge Continuum;

(91) Key research area (d), availability and accessibility, aims at rendering the developed tools and services widely and easily accessible. To that end, it includes activities relating to the development of the reference architecture, including its requirements and processes. Such requirements and processes need to be developed along uniform principles, best practices, data models and formats to ensure interoperability and data portability. The main aim of these capabilities is to ensure availability and accessibility of the reference architecture across providers (and types of services (edge / cloud). In addition, the XaaS layer, as a single set of common tools and services, enhances the availability and accessibility within the Continuum ecosystem. The R&D&I and FID phases of availability and accessibility contain the following indicative activities:

- establishing communication and cooperation operational modes, that will enable communication across different providers;

- working on data exchange and interoperability features which allow for new, multi provider business models with interoperable organisational methods.

(92) Finally, key research areas (e), security, and (f), sustainability, relate to capabilities that enhance data protection based on enhanced cybersecurity and energy efficiency based on monitoring and optimising energy usage. While they constitute self-standing research areas, they spread across the entire research scope of WS 2, as they apply to all capabilities that are explored in the context of this WS. The R&D&I and FID phases of these security and sustainability contain the following indicative activities:

- developing horizontally applicable mechanisms to provide federated security, i.e. authentication and authorization;

- defining horizontally applicable system for energy usage monitoring and optimisation.

Description related to the significant added value of the individual projects

Atos

(93) Atos' project aims to develop a software layer that will allow for the interconnection of various providers and offer workload orchestration capabilities. It will also provide cybersecurity features, enhanced with AI functionalities, as well as decarbonisation capabilities, through developing services for carbon footprint management.

Orange

(94) Orange's project is to develop a "telco cloud stack" that will enable the virtualization/softwarisation of network functions, to enable life cycle, data and workload management in order to operate distributed telco clouds. It will also include innovative orchestration components (e.g. services for threat prediction, protection detection and mitigation; monitoring of data flows and profiling; cloud/edge continuum integrated alerts system), as well as advanced cybersecurity services for telco/edge workloads. Finally, it will develop workload monitoring solutions, to enable energy optimisation.

SAP

(95) SAP's project focuses on the development and integration of an open reference architecture as the technological basis for the interoperable Multi Provider Cloud Edge Continuum. It will develop applications, algorithms and concepts for life cycle management, as well as components for resource efficiency and optimised workload distribution. It will ensure cybersecurity by exploring end-to-end secure data transparency and control. At the same time, SAP will develop AI solutions to optimise energy efficiency. Finally, it will work on the integration of contributions into the open reference architecture, thus rendering the final product available and accessible to all.

Reply

(96) Reply's project concerns the development of a software ecosystem and orchestration layers, specifically focusing on network management services. These will be able to link multiple and aggregate types of network resources (fixed and mobile), thus providing them as a seamless service and ensuring availability and accessibility. Reply will also develop an intelligent security framework, able to optimise resource usage efficiency and to guarantee the QoS for these services, in particular in terms of latency and bandwidth. In addition, the project includes the provision of a platform for the delivery of autonomous guided vehicles services as a cloud/edge platform.

TIM

(97) TIM's project contributes to WS 2 by designing, developing and building a next generation unified and integrated telco cloud stack for managing and

orchestrating the distributed Multi Provider Cloud-Edge-Continuum. To achieve this, TIM will ensure interoperability and federation in a highly automated continuum geo-distributed and multi provider infrastructure. All tools and services developed by TIM will include enhanced user data privacy and provide operator support in security management decisions.

Oktawave

(98) Oktawave's project focuses on the security aspect of workload management and processing in distributed and federated near-edge and cloud services. It will develop a technology to secure data processing in the public cloud in a way that technically prevents cloud providers from accessing the data entrusted to their infrastructure. It will also enable the trustworthy backup of distributed data in the cloud storage.

Atende

(99) Atende contributes to WS2 by developing a solution targeting workload and data management with a database solution for safe, scalable and energy efficient storage of time-stamped data. This will include mechanisms guaranteeing redundancy that can run without failure in far and near edges, as well as small edge devices.

Open Nebula

(100) Open Nebula aims to develop a meta-orchestrator that will enable life cycle and data management, by providing solutions to manage disaggregated resources and federated cloud controllers. It will also work on workload placement by developing a hierarchical scheduling model. In the field of security, Open Nebula will develop an AI-based solution for the enforcement of security policies, automated detection and mitigation of cybersecurity threats. It will also provide advanced functionalities for energy usage analysis, modelling and optimisation.

Arsys

(101) Arsys' project focuses on two main areas: data centre management, monitoring tools and cloud marketplaces. For data centre management, Arsys will develop solutions for the optimisation of the data centre operations, including its sustainability, through a digital twin. Arsys' cloud marketplace will include a hybrid cloud management and meta-orchestration platform, including life cycle and workload management, enabling customers to adopt and use multi-cloud solutions. Through these technologies, Arsys will ensure availability and accessibility for users, allowing them a reliable and transparent interaction with the services used.

Leaseweb

(102) Leaseweb's project will develop the architecture and key building components to enable interconnecting platforms, thus ensuing orchestration, life cycle and cross-provider management, as well as wide accessibility and availability of the Multi Provider Cloud Edge Continuum. Leaseweb will achieve this by developing, first, an IaaS layer for secure and scalable data storage and, second, an XaaS layer encompassing seamless interconnection and vertical integration with application development toolsets.

Description related to the complementarity of the individual projects

(103) The individual projects of WS 2 are complementary to each other, as each undertaking focuses on a different aspect, while at the same time there are synergies between some of them: Orange and TIM offer their expertise in telecommunication-specific aspects, by working on the integration of telco edge workloads (Orange) and on the telco cloud integration (TIM). At the same time, the cloud providers Arsys, Atos, Leaseweb, Open Nebula and Oktawave focus on various aspects of services management, such as: orchestration capabilities for workload placement (Atos), methods for cryptographically secure data processing (Oktawave), control models that allow users a more transparent and reliable interaction with their services (Arsys and Leaseweb), and management solutions for disaggregated resources (Open Nebula). Further, the software solution providers Atende, Reply and SAP contribute with the development of applications necessary for the reference architecture; for instance, Atende focuses on aspects of data management, Reply focuses on mobile and fixed networks software management, while SAP works on the development and overall integration of the reference architecture.

(104) Figure 5 illustrates the main contributions of the individual projects to the key research areas, based on the significant added value they bring to WS 2, as described in this Section:

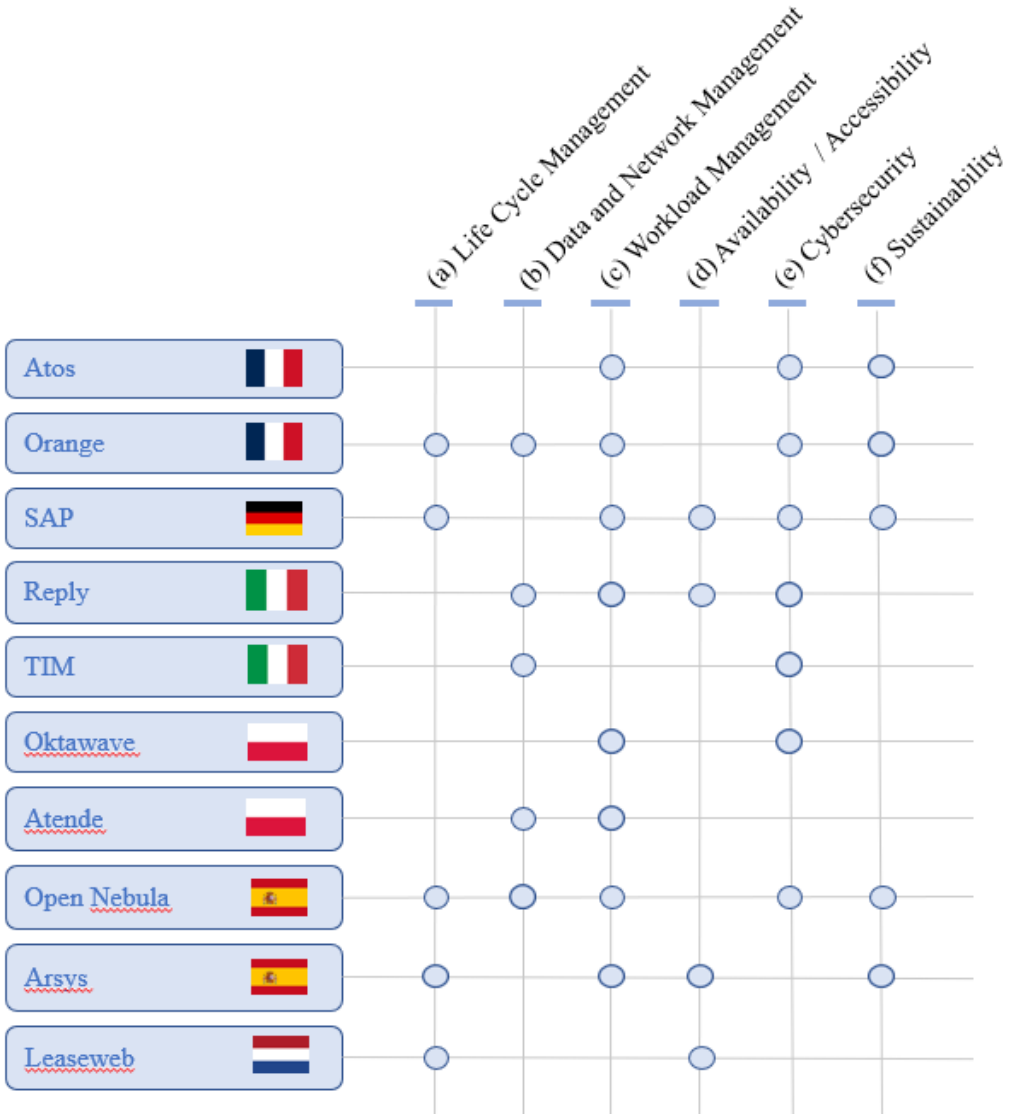

Figure 5 - Main contributions of individual projects in WS 2

(105) The complementary character of the individual projects is further illustrated by a number of collaborations within the WS, as explained in section 2.5.6.1.

2.5.3. Significant added value and complementarity of the individual projects for the achievement of the goals of WS 3

(106) WS 3 involves four participating undertakings, namely 4iG, E-Group, Tiscali and Cloud Ferro.

(107) The individual projects of the participating undertakings will contribute to this WS by providing significant added value by building a set of advanced cloud and edge services that can be deployed seamlessly across networks of providers. This requires the definition and implementation of ready to use, fully configurable, modular processing services that are reusable in many application contexts. More specifically, the R&D&I and FID activities of WS 3 can be grouped into three key areas of research: (a) data handling in distributed and federated data processing facilities, (b) distributed and federated Artificial Intelligence (AI) services, as well as (c) life cycle management and service orchestration in distributed and federated data processing facilities.

(108) Research area (a) concerns data handling in distributed and federated data processing facilities, more precisely the ability to describe, transform, exchange, store, and retrieve data in a secured, compliant, and efficient way across highly distributed environments. The respective R&D&I and FID phases of this key research area contain the following indicative activities:

- developing data mesh concepts to support all types of data (streaming, event, real time);
- managing exchanges over a federated and highly fragmented cloud-edge ecosystem (distribute data across diverse environments (Cloud/Edge) and/or different providers including machine-readable descriptions of types and characteristics of data;
- developing management solutions for data distribution, including the security of distributed data, access, storage and exchange;
- developing ecosystems platforms and components to facilitate re-use of services and components throughout all ecosystems.

(109) Research area (b) concerns AI Services as advanced functionalities that must be developed to foster the adoption of AI throughout all application domains and which need to be deployable on distributed sets of data and processing resources as opposed to the centralised paradigm currently employed. This concerns, among others, advanced federated learning services, or improving ecosystem analytics and optimization and user experience. Other focal aspects are the sustainability of AI services by avoiding unnecessary data transfer and the exploitation of heterogeneous processor architectures. The respective R&D&I and FID phases of this key research area contain the following indicative activities:

- developing network functions and applications for intelligent services provisioning in cloud/edge environments to enable self-configurable applications and optimal execution of AI workloads;

- developing tools and support for Machine Learning (ML) models versioning, continuous deployment and delivery, continuous training and monitoring of ML systems in federated cloud/edge environments;

- developing specific AI/ML services to enable advanced use cases;

- developing front end tools for management by users;

- development of software tools enabling a consistent management of a large number of different reusable components and set of models for an open-source AI ecosystem and platform.

(110) Research area (c) concerns life cycle management and the development of service orchestration solutions to deliver a unified application management environment. Those management tools cover the application layer of the Cloud Edge Continuum and are used for the process of integrating two or more applications and/or services together to automate a process or synchronise data in real-time. This is essential to manage and monitor applications at runtime. The respective R&D&I and FID phases of this key research area contain the following indicative activities:

- developing tools to provide a unified virtual infrastructure for application deployment across several providers;

- developing tools to extract data/information from different environments and provide unified systematic view of state of resources (logging, monitoring, alerting);

- developing tools for the implementation of role-based access right systems;

- developing the capabilities for the automated deployment of distributed applications on the cloud edge continuum (ensuring high availability and reliability);

- developing tools for monitoring the behavior and resource consumption of executed (distributed) applications;

- developing tools and processes for managing the lifecycle of applications.

Description related to the significant added value of the individual projects

4iG

(111) 4iG's project aims at developing a universal and interoperable open data authentication solution based on block chain technology for all data sources that is open to all users, regardless the industry or company size. The project will provide a data authentication platform service that can be used to authenticate large amounts of data and verify its authenticity, integrity and completeness before use. The uniform digital data fingerprinting solution developed within the

4iG project will enable secure data authentication/handling across industries and companies.

E-Group

(112) E-Group's project aims at providing federated learning data processing services that covers the privacy preserving Cloud-Edge continuum, the use of AI to enable new services and the life cycle management of the processing services. The project will enable to decouple data processing services from the insight generation so that the algorithms can go to data or ML algorithms can train on encrypted data sent to compute depending on available resources or user needs without sharing data' private content. E-Group's project aims at unifying the federated AI concepts and providing energy efficient federated learning algorithms to reduce environmental impact of large-scale machine learning by processing data over the network instead of moving the data.

Tiscali

(113) Tiscali's project will enable the creation of a distributed data model and infrastructure, a real-time access framework, and an application development framework to implement AI algorithms. More specifically, the project aims at creating Multimodal and Multilingual Generative-AI models that generate high-quality textual and multimedia content in real-time and provide accurate time-series forecasting. In addition, the project is also aimed at developing a set of AI tools and services for data processing and analysis, aggregation, and exploration in the context of low code/no code service-based AI application development.

CloudFerro

(114) CloudFerro's project focuses on the management and processing of spatial data ([24]) mainly satellite data but not only, on the cloud and edge. The project will develop resources to catalogue and index geo-spatial data, distribute workload to execute tasks, while taking advantage of batch and stateless container processing, as well as user and identity federation. Moreover, the project aims at developing edge nodes dedicated for stateless processing tasks, that can be located directly at renewable energy sources, optimizing the use of green renewable energy, and lowering the carbon footprint of the information produced. It will also enable the creation of data pipelines that allow for workflows on data transformation throughout all resources of the Multi Provider Cloud Edge continuum.

Description related to the complementarity of the individual projects

(115) The Member States submit that the projects in WS 3 are complementary, because the participating undertakings provide their expertise in their respective fields by contributing to the different research areas and offer solutions for different, heterogeneous requirements, while partially overlapping. All key research areas, as well as all aspects of the same area explored by the individual projects of companies with various backgrounds are necessary to achieve the main objective of WS 3 to build a set of advanced cloud and edge services that can be deployed

([24]) All data that refers to a particular geographic area or location is considered spatial data. Sometimes it is referred to as geographic information or geospatial spatial data.

seamlessly across provider networks. As described more detailed above the project of Cloud Ferro (cloud provider) focuses on various aspects of data management, harvesting, aggregation, while the project of E-Group (software solution provider) focuses on data integrity aspects. Finally, the projects of 4iG and Tiscali (telecommunication providers) complete WS 3 with their telco specific expertise.

(116) Figure 6 illustrates the main contributions of the individual projects to the key research areas, based on the significant added value they bring to WS 3, as described in this Section:

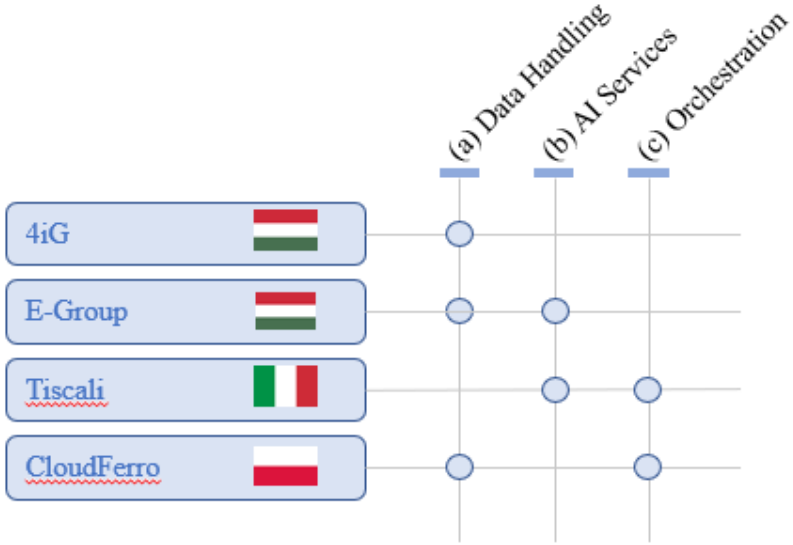

Figure 6 - Main contributions of individual projects in WS 3

(117) The complementary character of the individual projects is illustrated by a number of collaborations within the WS, as explained in section 2.5.6.1.

2.5.4. Significant added value and complementarity of the individual projects for the achievement of the goals of WS 4

(118) WS 4 involves three participating undertakings, namely Siemens, Fincantieri and Engineering.

(119) The individual projects of the participating undertakings in this WS aim at developing solutions for complex sector specific use cases to demonstrate and validate the maturity of the Multi Provider Cloud Edge Continuum in an industrial environment (i.e., to demonstrate that they can be integrated in the Continuum and that their results can be transferred to other sectors by developing proof of concept, blueprints and best practices). The R&D&I and FID activities within WS 4 can be grouped into three key research areas regarding the implementation and operation of complex cloud edge applications on (a) IT/OT convergence, (b) industrial digital twins and AI integration in operational processes, as well as (c) data ownership, control, and security. The key research areas of WS 4 continue the R&D&I and FID activities of WS 1 to 3.

(120) Key research area (a) focuses on closing the gap between the cloud edge IT (information technology) domain and the industrial OT (operation technology) domain regarding integration and operation of complex industrial applications. The R&D&I and FID phases contain the following indicative activities:

- developing a deep integration of novel solutions within the common reference architecture to meet diverse industrial-grade requirements as hard real-time, uninterrupted stability, certifiable safety guaranteed longevity, or brownfield connectivity;
- achieving transferability of edge connectivity across a broad set of different industrial application scenarios;
- developing the transfer of traditional operational paradigms to the operational paradigm of the cloud edge IT domain (Agile-DevOps-SRE) to produce significant innovations regarding the automated testing and proof of industrial-grade security, regulatory compliance and interoperability.

(121) Key research area (b) focuses on challenges regarding the development of common approaches for the integration of the digital twin concept in the cloud edge continuum across various fields of application as well as to the application of AI to resolve operational issues. The respective R&D&I and FID phases contain the following indicative tasks:

- extending the digital twin paradigm to become a key mechanism to achieve transferability of sector-specific solutions, e.g. usage in the Multi Provider Cloud Edge Continuum across industrial sectors;
- developing capabilities for distributed storage, reuse of sector-agnostic processing components, standard-based interoperability mechanisms, integration of machine learning, IoT data processing;
- developing a digital twin platform that will allow IT-non-experts to use the digital twin paradigm through low code/no code approaches for cross-sector use based on a common framework and its integration with the Multi Provider Cloud Edge Continuum, as well as the development of blueprints to allow concept application to related application areas, e.g. regarding the use of data from digital twins;
- advancing the creation and performance of digital twins as well as to process complex, distributed data, by using AI at application level;
- building AI solutions to address sector specific operational challenges i.e. intermittent connectivity, high latency to resolve connectivity problems at network level to guarantee proper access to edge cloud resources.

(122) Research area (c) focuses on the development of solutions with respect to security of data and control of its usage. The respective R&D&I and FID phases contain the following indicative tasks:

- Developing of a practical application of a compliant, federated data exchange, including data of the energy market, the existence of roaming and interoperability agreements, the fulfilment of latency requirements, as well as automation and scalability of critical software components;

- developing and integrating cybersecurity measures for protection against data theft and data manipulation and to ensure the trustworthiness of the AI-based results.

Description related to the significant added value of the individual projects

Siemens

(123) Siemens' project aims at developing a software solution to digitalise the industrial sector in the context of IT/OT convergence. Its software will enable the "edgification" (i.e., the integration of edge computing capabilities to devices that so far did not support such capabilities) of all industrial equipment and devices, old and new. The software will be provided with a connectivity suite, providing guidance for its installation and operation even to non-IT experts, thus closing the gap between IT and OT. Siemens will also offer a testing ecosystem, where interested companies may test such edge applications. The result of the various applications of Siemens' software in industry will be gathered and published in the IT/OT convergence playbook.

Fincantieri

(124) Fincantieri's project aims at demonstrating the application of Edge-cloud continuum in specific application domains through developing solutions for the ship construction industry (e.g. by developing digital twins). It comprises the use of digital technologies for the optimization of ship operations, integrating and orchestrating advanced Cloud and Edge based features into lifecycle management of complex systems as well as implementing threat intelligence strategies into the maritime applications by developing advanced AI solutions to overcome operational challenges like high latency or limited connectivity.

Engineering

(125) Engineering's project contributes to WS 4 by providing an orchestration system to enable portability between different cloud-edge resources, services and providers, and data interoperability and management capabilities. Moreover, it provides a digital twin platform that supports the creation of digital twins exploiting cloud-edge processing resources including cybersecurity. Engineering develops solutions exploiting digital twins in domains which are critical for EU's economy and prosperity (manufacturing, cultural heritage, energy, health).

Description related to the complementarity of the individual projects

(126) The Member States submit that the projects in WS 4 are complementary, because the participating undertakings provide their expertise in their respective fields by contributing to the different key research areas and offer solutions for different, heterogeneous requirements, while partially overlapping. All research areas as well as all aspects of the same area explored by the individual projects of companies with various backgrounds as industrial (Siemens and Fincantieri) or software solution provider (Engineering), are necessary to achieve the main objective of WS 4.

(127) Figure 7 illustrates the main contributions of the individual projects to the key research areas, based on the significant added value they bring to WS 3, as described in this Section:

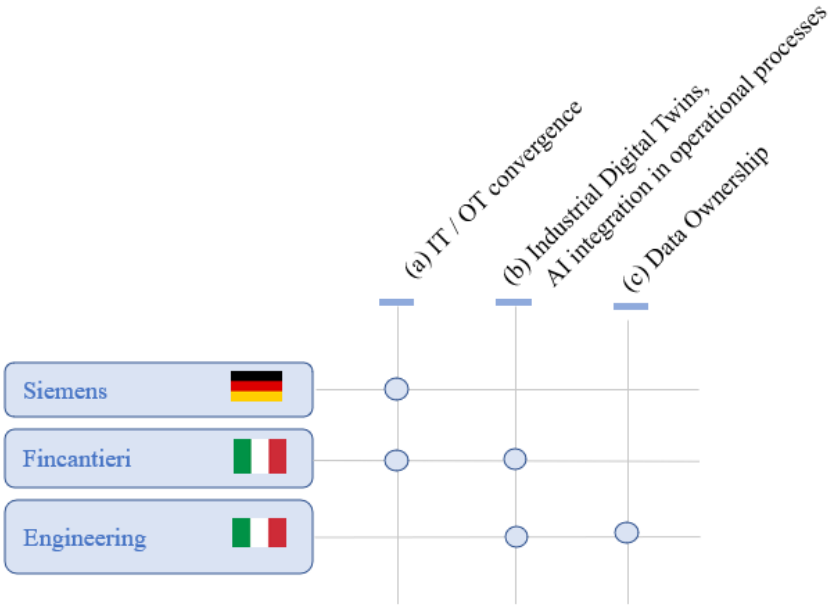

Figure 7 - Main contributions of individual projects in WS 4

(128) The complementary character of the individual projects is illustrated by a number of collaborations within the WS, as explained in section 2.5.6.1.

2.5.5. Significant added value and complementarity between the WS for the achievement of the goals of IPCEI CIS

(129) The Member States submit that each of the four WS significantly adds value to and is complementary to each other to meet the objectives of IPCEI CIS (see Section 2.2).

2.5.5.1. Significant added value of WS 1 and its complementarity with other WS

(130) WS 1 significantly adds value to the Multi Provider Cloud Edge Continuum by developing all necessary capabilities to enable the seamless operation of different types of data processing facilities as a joint Multi Provider Cloud Edge Continuum. To this end participants will be designing, developing, and testing hardware-related software and network integration solutions for different types of data processing locations from central data centres, near and far edge, to on-premises edge, as well as ensuring their security, sustainability and availability. The results form the foundation for the solutions developed in workstreams 2, 3, and 4.

(131) Concerning the complementarity with other WS:

- WS 1 is complementary to WS 2: The suitable abstraction layer provided in WS 1 enables uniform access to infrastructure resources across providers including different types of data processing facilities and advanced interconnection of networks in WS 2.

- WS 1 is complementary to WS 3: the underlying infrastructure developed in WS 1 ensures that the requirements of the advanced services developed in WS 3 are met e.g. by ensuring that a real-time data analytics service

receives the data with guaranteed maximum latency and minimum bandwidth, while it offers hardware optimisation that support data analytics performance requirements.

- WS 1 is complementary to WS 4: by ensuring that the requirements of advanced applications are met by the underlying infrastructure, e.g., by providing a predictable performance of complex applications even if the components of the application are spread across various data processing facilities of different providers.

2.5.5.2. Significant added value of WS 2 and its complementarity with other WS

(132) WS 2 leads to the development of a common reference architecture for the Multi Provider Cloud Edge Continuum based on the necessary capabilities developed in WS 1. This architecture will provide a uniform interface across providers that will facilitate federation, access and management of the data processing resources available in the Cloud Edge Continuum. The reference architecture will be the basis for advanced tools and services developed in WS 3 as well as complex applications developed in WS 4.

(133) Concerning the complementarity with other WS:

- WS 2 is complementary to WS 1: WS 2 provides the requirements of the common reference architecture that the underlying data processing infrastructure of WS 1 needs to meet, e.g., providing hardware blueprints and requiring ways to discover available data processing resources, to be notified of failures, or to be able to specify QoS demands.

- WS 2 is complementary to WS 3: the reference architecture developed in WS 2 as a high-level, uniform abstraction layer allows the implementation of advanced tools and services without dealing with particularities of the underlying data processing infrastructure.

- WS 2 is complementary to WS 4: through the development of a reference architecture in WS 2, the deployment and operation of complex cloud edge applications in WS 4 is feasible, e.g., by providing the necessary capabilities for the lifecycle management of such applications.

2.5.5.3. Significant added value of WS 3 and its complementarity with other WS

(134) WS 3 will contribute to develop a first set of advanced tools and services that can be deployed seamlessly across provider networks and are reusable in various application contexts as building blocks for cross-domain service integration. These tools and services are built on top of the reference architecture developed in WS 2 and the testing infrastructure of WS 1. They represent solutions to particularly challenging, cross-domain demands in a Cloud Edge Continuum, e.g., distributed machine learning and distributed data management. As such they serve as means to ensure that the underlying technology stack developed in WS 1 and 2 can meet these advanced demands and enable the testing of domain-specific application within the use cases in WS 4.

(135) Concerning the complementarity with other WS:

- WS 3 is complementary to WS 1: While WS 1 provides the underlying infrastructure resource readiness for testing purposes, WS 3 defines requirements for particularly advanced services that need to be addressed in the necessary capabilities of the underlying infrastructure, e.g., to be able to access specialised computing hardware, and by providing a test environment, which can validate if those requirements were met.

- WS 3 is complementary to WS 2: The requirements of particularly advanced services regarding the necessary capabilities of the reference architecture developed in WS 2 are generally needed, e.g., to manage the distribution of workloads according to some optimisation criteria. Furthermore WS 3 provides a test environment, which can validate if those requirements were met.

- WS 3 is complementary to WS 4: The advanced tools and services developed in WS 3 are reusable in different application scenarios and use cases in WS 4, e.g., providing advanced machine learning services that enable the development of complex cloud edge applications in a modular fashion.

2.5.5.4. Significant added value of WS 4 and its complementarity with other WS

(136) WS 4 adds value to the completion of the three other WS as it will contribute to develop a first set of feature complete, domain-specific applications utilising the Multi Provider Cloud Edge Continuum. These applications are enabled by the infrastructure resources provided in WS 1 and are built on the reference architecture of WS 2 as well as on the advanced cross-domain services of WS 3. The development of domain-specific applications identifies technical, operational, and organisational challenges and respective requirements that only emerge in sufficiently complex application scenarios.

(137) Concerning the complementarity with other WS:

- WS 4 is complementary to WS 1: The complementarity of WS 4 and WS 1 is shown by the validation of the expected performance of the underlying data processing infrastructure of WS 1 in complex, domain-specific use cases, and potentially uncovering unforeseen challenges related to the federation of processing facilities from different providers in different Member States in WS 4.

- WS 4 is complementary to WS 2: a specific contribution from WS 4 to WS 2 is the validation of the expected performance of the reference architecture developed in WS 2 in complex, domain-specific use cases, and potentially uncovering unforeseen challenges related to the overarching control and management of interoperable cloud and edge resources.

- WS 4 is complementary to WS 3: WS 4 is expected to develop requirements for reusable, advanced services in different, domain-specific application contexts, and test the advanced tools and services developed in WS 3 in a domain-specific environment.

(138) The significant added value and complementarity is illustrated in particular by the multiple collaborations between the participating undertakings contributing in the different WS, as described in section 2.5.6.

2.5.6. Collaborations within IPCEI CIS with respect to the relevant WS

(139) In addition to the significant added value and complementarity of the individual projects within each WS, according to the information provided by the Member States, strong collaborations of the participating undertakings within and across the WS are planned, which, which, according to the Member States would not occur to the same extent and within the same time frame without IPCEI CIS.

2.5.6.1. Examples of collaborations intra WS

(140) In WS 1, there is the following example for collaboration:

- DTAG and Telefónica will collaborate in research and development of open reference edge cloud infrastructure elements. While Telefónica focuses on enhancing the integration of near edges, DTAG focuses on the necessary interconnection of such systems. Together, this will result in open-source reference implementations and blueprints for the integration and interconnection of secure, near edges. Furthermore, DTAG and Telefónica will jointly work on research and development of Edge Federation Capabilities and a Telco Cloud Stack with a focus on the specific requirements of telco workloads in the Cloud Edge Continuum. Telefónica focuses on making the edge infrastructure "telco-ready" by integration, federation and orchestration mechanisms, standardisation of the interfaces for edge federation, and developing open-source code for the edge federation APIs. DTAG will develop the telco- and network-related capabilities as well as contributing open-source cross-network, cross-country QoS solutions. Both operators will develop a certification program to validate network functions in order to accelerate the adoption by other European telecom operators.

(141) In WS 2, there are the following examples for collaboration:

- The collaboration between Atos and Oktawave will be on edge to cloud orchestration and cybersecurity ensuring that the Oktawave cloud platform is interoperable with Atos' edge-centric orchestration layer. Regarding research and development in cybersecurity, Atos focuses on identity and access management as well as DevSecOps ("DevOps with security by design") while Oktawave will develop securing sensitive workload processing by cryptographic means.

- Orange and TIM have agreed to collaborate on the Telco Cloud Stack. Orange will focus on the architecture, the compliance with standards (common APIs), bare metal automation, real time open-source capabilities, and the scalability of the containers-as-a-service (CaaS) layer. TIM will provide networking automation, workload management, and optimized life cycle management.

- The cooperation between SAP and Leaseweb will enable the development of container-based application management including enhanced capabilities for monitoring and control. SAP will develop an open-source

architecture level where Leaseweb will integrate its specific components related to data management, operational metrics, and ML. With SAP's assistance, Leaseweb will be able to deliver a reference architecture alongside the platform and customise the platform to meet the needs of a wider client base by addressing both the software architectural perspective and the Cloud Infrastructure view.

- The collaboration between Reply and OpenNebula targets the development of innovative methods for AI/ML support in multi provider cloud-edge operations, mechanisms for usage and congestion control, and methods for resource workload balancing. The focus of Reply lies on data-exchange and processing services for usage and congestion control as well as resource balancing, while OpenNebula will explore AI/ML methods, focusing on scalability, high degrees of distribution, and cross-provider deployments.

(142) In WS 3, there are the following examples for collaboration:

- CloudFerro and Tiscali will collaborate on data analysis and real-time representation as well as the application of geospatial continuum concepts to a tourism use case. Cloudferro will design and develop algorithms to continuously collect, analyse and utilize data derived from geographical information systems to provide a comprehensive understanding of the Earth's surface and its various attributes, allowing for a dynamic and real-time representation of the world. Tiscali will use this data to create a set of AI-based business capabilities as reusable building blocks.

- 4iG and E-Group have agreed to cooperate on the development of securing distributed data exchange solutions. This includes novel methods for user identification, verification of data and algorithms, platform workflow management and data usage authentication, as well as billing.

(143) In WS 4, there are the following examples for collaboration:

- Siemens and Fincantieri will jointly work on the implementation of on-premises edge computing in selected Fincantieri “Smart Yard” application scenarios, e.g., predictive maintenance, optimisation of operations, and fault detection. Siemens will contribute their solutions for IT/OT convergence in on-premises edge computing, while Fincantieri will contribute their expertise and solutions regarding the use of digital twins and asset administration shells within the context of Cloud-Edge-Continuum-based workflow management in the manufacturing environment.

- The cooperation of Siemens and Engineering will enable the integration of the Siemens IT/OT convergence solution with Engineering’s digital twin platform to establish and proof the interoperability of both solutions. Siemens will provide an Edge environment to host digital twins locally close to the source of data and keep the twins updated with live process values. Engineering will provide the corresponding digital twin Platform to operate on these digital twins.

- Fincantieri will collaborate with Engineering on the development of a standardised cloud edge workflow management for digital twins with a

particular focus on the aggregation of processing services and cybersecurity aspects. Fincantieri will provide the application context and work environment, while Engineering will focus on the necessary foundation services and their encapsulating in a digital twin platform.

2.5.6.2. Examples of collaborations inter WS

(144) Concerning the collaborations between WS 1 and WS 2 the following examples show the complementarity of the individual projects:

- DTAG and TIM will jointly work on an edge blueprint definition, meta-orchestration, edge federation and a telco cloud stack. The focus of DTAG will be on the development of infrastructure elements and interconnection requirements, the feature roadmap (regional breakouts, etc.), telco- and network-related capabilities, as well as contributing to the respective open-source developments (regional breakouts, booking functionalities, etc.). TIM will take part in the development of edge blueprint models, definition of multi operator orchestrator models, federation models among operators as well as federation APIs, telco cloud stack definition of networking automation, workload management and optimized Life Cycle Management.

- The cooperation between Telefónica and SAP aims the development of a blueprint for a joint open reference architecture. Telefónica will concentrate on the deployment of infrastructure elements of R&D&I activities, more specifically edge nodes, bringing in their requirements. In contrast, SAP will focus on cloud and on-premises edge as well as on the validation and testing of the integrated software by deploying it on the infrastructure elements developed by Telefónica.

- DTAG and OpenNebula will collaborate on the development of innovative methods for the interoperability between cloud providers, support of software defined networking (SDN), and real-time metrics collection. DTAG will focus on the areas of management of network as a service functionality, APIs, and data models to ensure interoperability. While OpenNebula will work on prototyping of methods and APIs for interoperability in multi-provider cloud edge environments, the support of SDN, and real-time metrics collection.

(145) As regards the collaboration between WS 1 and WS 3:

- The cooperation of Telefónica and Tiscali will enable the development of criteria for an Edge Cloud Continuum (which kind of edge nodes in which kind of locations/facilities), that combines the infrastructure elements and capabilities of multiple providers following the multi-cloud Orchestration and Federation mechanisms defined and developed. The collaboration includes testing and validation of the interconnection and federation of the different first edge cloud deployments developed by Telefónica (at all kinds of locations: central, near, far, on-premises edge), based on efficient technologies along with the required operational process to assure highly automated operations supporting service quality and efficiency.

(146) Concerning the collaborations between WS 1 and WS 4:

- DTAG will collaborate with Fincantieri on the development of advanced edge services in the field of autonomous logistics. They will jointly work on the design, implementation and test of the respective technologies as well as the execution of a first set of proof of concepts. DTAG will focus on interconnection and foundation services to allow mobile vehicles to access the resources of the cloud edge continuum. While Fincantieri will work on service management, the integration of autonomous vehicles with ongoing non-autonomous operations, and the cooperation between autonomous vehicles and on the priority to be assigned to the Processing Services.

- DTAG and Siemens will jointly work on the utilization of public 5G for SME use cases like visual inspection and for the connection of (mobile) edges in a brownfield environment. Both companies will engage in proof of concepts in real world SME use cases utilising connectivity solutions developed by DTAG and IT/OT edge technology developed by Siemens.

(147) The complementarity between WS 2 and WS 3 is also evidenced by a number of envisaged collaborations:

- The cooperation of Arsys and Tiscali will enable the design of development criteria for an Edge Cloud Continuum as well as the test and validation of the interconnection and federation of different first edge cloud deployments. Arsys will be responsible for designing and developing the chain from cloud to edge, while Tiscali will handle the edge nodes, determining the types and locations of facilities, and validating the architectural model in accordance with the planned use cases. The utilization of Generative AI to autonomously generate novel design solutions that will enhance the decision-making process regarding the choice of optimal edge node types and their strategic placement will be an important aspect of their collaboration.

- SAP and CloudFerro will cooperate in the fields of user management, federation, and authentication. The results developed by this cooperation will be included in the open reference architecture developed by SAP. CloudFerro will develop technologies for user management, federation and authentication which will be integrated in the blueprints of SAP's open reference architecture. SAP will leverage the open reference architecture blueprints for user management, federation and authentication in the proofs of concept developed by CloudFerro.

- OpenNebula and E-Group will collaborate on the design and development of a federated AI/ML technology stack including techniques for explainable AI and the integration with medical data repositories. OpenNebula will focus on the verification of methods and APIs for the deployment of federated learning applications along the continuum. E-Group will implement these results within the framework of pilot projects.

- Reply and CloudFerro will jointly work on the definition of resources, required information and standards related to cloud edge requirements for urban hybrid mobility use cases (autonomous electric vehicles and transportation) enhanced by earth observation data and detailed urban digital twins.

(148) Concerning the collaborations between WS 2 and WS 4:

- Atos and Engineering will collaborate on developing solutions for the operation of ML algorithms, commonly named as MLOps (Machine Learning Operations) for the edge. One of Engineering's goals in this respect is to provide data of better quality that later on can be operationalized through the MLOps developed by Atos and Engineering. Another point for collaboration is in the development of common designs and APIs for orchestration and interoperability. While Atos main focus is on orchestration, Engineering`s is on providing solutions for interoperability.

- The collaboration of OpenNebula and Siemens aims to enable cloud edge orchestration across platforms covering Siemens on-premises edge, resulting into the tailoring of the OpenNebula cloud-edge orchestration according to Siemens' specific Industry requirements. OpenNebula will work on methods and APIs for supporting the provisioning and deployment of relevant Siemens' edge cloud and edge node architectures. Siemens will focus on management functionality, APIs, and data models to enable the orchestration of industrial on-premises edge infrastructures across platforms.

- Arsys and Engineering will jointly work on the reciprocal interconnection of APIs to enable the functioning of meta orchestration solutions. In addition, the companies will collaborate on the optimization of processing services to be run on distributed computing nodes. Arsys will focus on the development of a common validation framework. Engineering will design the specific test scenarios to be considered and both companies will analyse domain-specific requirements.

- Atende will collaborate with Engineering on the development of edge-based time-series data management in critical environments like healthcare. Atende will focus on solutions for collecting and storing high volume, high frequency time-series data directly at the edge. While Engineering will focus how to process the collected data and integrate it with cloud services.

(149) Concerning the collaborations between WS 3 and WS 4:

- Fincantieri and OpenNebula will collaborate on the development of meta-orchestration of continuum computing capabilities and the secure deployment of edge applications and advanced services in mobile and in hybrid mobile-nomadic environments. OpenNebula will focus on the prototyping of methods and APIs for supporting IaC (infrastructure as a code) operations and GitOps workflows in edge cloud environments involving mobile bare-metal resources, and the automated deployment of multi-tier, containerized applications using edge-aware Kubernetes clusters. ([25]) Fincantieri will evaluate the meta-orchestration of continuum

([25]) Infrastructure as code (IaC), Edge-aware Kubernetes clusters and GitOps are explained in Annex III – Glossary of technical terms.

computing capabilities and secure the deployment of edge applications and advanced services in mobile and in hybrid mobile-nomadic environments.

- 4iG and Engineering will jointly work on the development of data authentication capabilities (guaranteeing data authenticity, reliability, verifiability), data sovereignty and security mechanisms for distributed data. Within the common development of data authentication, 4iG will focus on data authentication. While Engineering will focus on the areas of data sovereignty and security.

- The collaboration between CloudFerro and Engineering will enable the definition of standards, frameworks and APIs for resource management and task scheduling in cloud edge systems. These will be instrumental to define, develop and deploy smart cities use cases in cloud edge systems, enhanced by Earth Observation data. CloudFerro will focus on the definition and deployment of smart city use cases, which will be managed by Engineering.

2.6. Positive spillover effects generated by IPCEI CIS

(150) The Member States submit that IPCEI CIS will generate important dissemination and spillover effects across the Union. This dissemination will be made possible through:

(a) Dissemination and spillover of results that are not protected by intellectual property ("IP") rights (see section 2.6.1);

(b) dissemination and spillover of results that are protected by IP right (see section 2.6.2);

(c) dissemination and spillover through the use of open-source software (see section 2.6.3);

(d) dissemination and spillover of results during the R&D&I and FID phase: access to infrastructure (see section 2.6.4);

(e) dissemination and spillover of results during the FID phase: use cases (see section 2.6.5); and

(f) dissemination and spillover results to indirect partners (see section 2.6.6).

(151) The individual projects notified as part of IPCEI CIS detail that each participating undertaking commits to and will participate in activities enabling dissemination and spillover effects up until, and including, the final eligible year of each individual project (see Table 13 under recital (188)). The FG will be responsible for monitoring the implementation of the dissemination and spillover commitments.

2.6.1. Dissemination and positive spillover effects of results that are not protected by IP rights

(152) The dissemination and spillover of results that are not protected by IP is first presented (1) as a whole and then broken down into the following four subcategories: (2) participation in external events, (3) collaboration through the

Union collaborative R&D&I ecosystem (4) publications in scientific journals and (5) training events.

2.6.1.1. Overview of the dissemination and spillover strategy of non-IP-protected results

(153) The participating undertakings to IPCEI CIS commit to disseminate knowledge and the individual project results that are not protected by IP rights to the scientific community, to the industry as well as to the wider public.

(154) The table below displays the mapping of the main dissemination actions of the non-IP protected results of IPCEI CIS within the Union, including a quantification of the dissemination activities and the difference with the undertakings' "business as usual": ([26]) ([27])

Category of dissemination and spillover activities	**Examples of direct participants**	**Total expected value of Key Performance Indicators (KPI) vs. "business as usual" ([28])**
Dissemination to wider public		
Press releases Press releases at national and international level to provide regular updates about the results and progress, important dissemination activities, new offerings and strategic partnerships and to increase awareness on edge cloud benefits and IPCEI CIS innovations.	Arsys, Leaseweb, Oktawave, Open Nebula, Reply, TIM, Tiscali	393/80

([26]) The Member States have requested from the direct participants to submit estimates of the number of dissemination actions that they carry out ordinarily (i.e., "business as usual") and to compare them with the envisaged number of dissemination actions that they expect to carry out as part of the individual projects notified in IPCEI CIS.

([27]) More generally, the tables in section 2.6.1 aim at widely covering the scope of dissemination and spillover activities within IPCEI CIS. In order to provide a comprehensive overview, the tables include indicative and non-exhaustive, but still representative dissemination and spillover activities, that the Member States have committed to perform.

([28]) This column reflects the total value of expected KPIs for the respective dissemination and spillover activity (i.e. the number of conferences in which direct participants will take part, publications in scientific journals, etc) for the direct participants mentioned in this table, at an aggregated level. It presents first the total value of KPIs in the scenario where the individual project within IPCEI CIS is undertaken and the total value of KPIs in the absence of the individual project ("business as usual" for the direct participant).

Category of dissemination and spillover activities	Examples of direct participants	Total expected value of Key Performance Indicators (KPI) vs. "business as usual" ([28])
Publications in general magazines Publications in special editions about cloud/edge computing of leading newspapers and magazines both national and international, and engagement of C-level to target top tier media such as Politico, Euractiv and local wires (Reuters, Bloomberg, AFP, AP).	Arsys, Fincantieri, Leaseweb, Open Nebula, Reply	62/11
Dissemination to industry		
Organisation of industry events Project events that will leverage existing participant's community, customer and ecosystem.	4iG, E-Group, Fincantieri, Open Nebula, Reply, SAP	111/9
Exhibitor booths and sponsorships at industry events Exhibition booths/sponsorships in relevant cloud and edge industry forums including Open Infrastructure Summit, KubeCon, Cloud Fest, Mobile World Congress, etc.	Open Nebula, Reply, Siemens, Telefónica	155/39
Presentations in industry events	Orange, Reply, Telefónica	140/37
Dedicated open seminars and workshops Public webinars, hands-on sessions, or workshops with users of edge and cloud technologies.	Cloud Ferro, DTAG, Fincantieri, Orange, Reply, SAP	171/32
Industrial publications White papers or similar publications describing the state of technologies and products that will be developed.	Atende, Atos, DTAG, Open Nebula, Reply, TIM, Tiscali	120/20
Dissemination of scientific results		
Publication of scientific papers Publications in relevant scientific journals in cloud and edge computing fields, including IEEE Transactions on Cloud Computing, IEEE Cloud Computing, Journal of Grid Computing, Journal of Cloud Computing, and other IEEE or ACM scientific journals on cybersecurity and	4iG, Open Nebula, Orange	95/22

Category of dissemination and spillover activities	Examples of direct participants	Total expected value of Key Performance Indicators (KPI) vs. "business as usual" ([28])
cloud-to-edge domains		
Presentations with publication in scientific conferences Presentations in scientific conferences on cloud and edge computing or featuring special tracks in events like the IEEE International Conference on Fog and Edge Computing, IEEE Cloud Summit and the ACM/IEEE Symposium on Edge Computing; or thematic tracks in HPDC (IEEE International Symposium on High Performance Distributed Computing), Parallel Processing and Applied Mathematics (PPAM), DISC (International Symposium on Distributed Computing), and other IEEE or ACM scientific conferences on cybersecurity and cloud-to-edge domains	Atos, E-Group, Fincantieri, Oktawave, Orange	45/3
Organisation of scientific workshops Organisation Research Workshops on relevant scientific conferences on cloud and Edge Computing in topics like top Open Reference Architecture, etc.	E-Group, Leaseweb, Reply, Siemens, Tiscali	52/5
Funding a PhD PhDs will be funded in collaboration with top European Universities	4iG, Atos, Engineering, Orange, Reply, TIM, Telefónica	58/15
Funding a Master thesis Master thesis will be funded in collaboration with top European Universities	4iG, Engineering, Orange, Reply	107/15
Financed University Chairs New university chairs dedicated to research and cooperation activities in areas related to the IPCEI, such as Cloud-Edge, etc.	Atos, Fincantieri	16/7
Collaborations with ROs and Universities in R&D&I Research contracts with ROs (IMDEA Network, ITIC, I2CAT, ...) and universities	E-Group, Leaseweb, Orange, Reply	60/20

Table 1 - Matrix of dissemination and spillover strategy for non-IP protected results

2.6.1.2. Participation in external events

(155) The participating undertakings commit to participate in conferences and public presentations within the Union in the framework of international events listed in the following table, during which they will disseminate knowledge and the individual projects' results that are not protected by IP rights.

(156) These events will take place in multiple Member States including but not limited to those participating in IPCEI CIS. They relate to a number of different sectors beyond the sector(s) where each participating undertaking operates. They are open to participants from all Union Member States and ensure wide geographic coverage, beyond the participating undertakings.

(157) Table 2 includes a non-exhaustive list of examples of conferences and events, where direct participants will present their work:

Conference Title	**Participating undertakings**	**Main topics addressed (examples)**	**Years**
Cloud Expo Europe	Leaseweb, Open Nebula, Tiscali, DTAG, Oktawave, Arsys	• Innovations in the areas of intelligent management, operation and federation of large-scale cloud-edge infrastructures • Topic that can be presented during the conference: "Secure backup of application/data in-transit between different cloud computing centers" • Autonomous Mobile Devices • Cloud Computing for MSPs and SMEs • Data centre digital twin, meta-orchestrator, portal capabilities	2024, 2025, 2026, 2028, 2030
CloudFest	CloudFerro, Leaseweb, Oktawave, Arsys	• Management of distributed, autonomous Kubernetes clusters; Tennant isolation for	2024, 2025, 2026

Conference Title	Participating undertakings	Main topics addressed (examples)	Years
		batch processing engines; PUE in containerized DC • Topic that can be presented during the conference: "Securing IAAS environments by cryptography using cloud provider-resistant encryption key storage" • Data centre digital twin, meta-orchestrator, portal capabilities	
Alliance for the Digital Economy (IVSZ Menta Conference)	4iG	DTS – interoperable BC based data trust; DTS integration with industrial standards	2024 – 2027
Edge Computing EXPO Europe	Telefónica	2024: Evolution of the Telco Edge concept from 2018 to 2023, as well as how it is materialized with the development and deployment of edge computing infrastructure and open-source solutions. Presentation of results of Telefonica's project, its deliverables and their impact on cloud industry.	2024 – 2028
Space Tech Expo	CloudFerro	Energy-aware EO data processing;	2025, 2026
Medica Tradefair	E-Group	Sharing new research results and sector-specific use cases for federated learning	2026 – 2029
FIWARE summit and FIWARE related event on Digital twins	Engineering	The AVANT digital twin suite (all domains), presentations, workshops, hackathons	2024 - 2028

Conference Title	Participating undertakings	Main topics addressed (examples)	Years
Smart industry expo	Fincantieri	Digital Lifecycle Management 5.0 (in the sectors of Mobility and Smart Infrastructure)	2026, 2027
Computerworld – BEST in Cloud	Oktawave	Topic to be presented during the conference: "Automation for cryptographically secure runtime".	2025, 2026
ACM/IEEE Symposium on Edge Computing	Open Nebula	Progress beyond the state of the art in the research areas of resource-constrained, ultra-low-latency 5G and high-performance edge nodes	20225
International Conference on Systems and Control	Orange	Telco cloud stack, energy efficient data centre	2024, 2025, 2026
Intelligent Vehicles Symposium (IV2023 and further)	Reply	Autonomous Vehicle Collaboration Platform	2024, 2025
IEEE CloudCom	TIM	Management solutions for a multi-cloud environment	2026
API Days Europe	Tiscali, DTAG	Composable Applications	2024
International Conference on Data Science & Artificial Intelligence	Tiscali	Artificial Intelligence / Data Analytics	2024
Container Days	DTAG, SAP	Specific aspects of the projects depending on their progress, presentation of results and use cases	2026
Open RIE Conference	Siemens	• IPCEI CIS approach to an open cloud-edge continuum • IPCEI CIS Industrial Edge Open-Source	2024, 2025, 2026

Conference Title	Participating undertakings	Main topics addressed (examples)	Years
		Building Blocks • Industrial requirements on an open cloud-edge continuum, App testing and validation	
Kubecon, Cloudnativecon	SAP	Aspects of the Open Reference Architecture project, depending on its progress	2026, 2027
IoT World Forum	Atende	TStorage performance tests results in the context of IoT devices	2029
Digital-X	DTAG	Cloud2Edge Continuum as NextGen Cloud Infrastructure & Services	2024
Les Assises de la Sécurité	Atos	Cyberecurity	2024 – 2027
Digital Enterprise Show	Arsys	Data centre digital twin, meta-orchestrator, portal capabilities	

Table 2 - Events and conferences where direct participants will participate

2.6.1.3. Dissemination and spillovers through the Union collaborative R&D&I ecosystem

(158) The participating undertakings commit to disseminate the non-IP protected results acquired in the framework of IPCEI CIS to the scientific community through collaborations and research activities, related to the subject of their projects with research and knowledge dissemination organisations ("RO"), including universities.

(159) The participating undertakings will, in addition, finance and contribute to the creation or development of university chairs in the Union related to technologies developed under IPCEI CIS with a view to train future European scientists, experts, software engineers and operators.

(160) The locations of the research organisations ("ROs") go beyond the Member States participating in the IPCEI CIS (e.g., Denmark, Sweden, Estonia, Portugal), thus providing wider spillover effects to the EU.

(161) Table 3 includes a non-exhaustive list of examples of ROs, which will benefit from the dissemination of the results of IPCEI CIS:

RO	**Participating undertakings**	**Topics concerned/ Scope of the Collaboration**	**Member State**
Cefriel	TIM, Fincantieri, Arsys	Collaborations and research activities about XR streaming platform, AI/ML for green mobility services	IT
ENEA, Italian national agency for new technologies, energy and sustainable economic development	TIM, Reply, Fincantieri, Engineering, Arsys	• Green-Secure-Open edge cloud infrastructure; AI/ML; critical infrastructures; smart applications/mobility support service • Collaboration on HPC-enabled simulation and training of WS4 – Smart Mobility / Industry 4.0-5.0 software applications for autonomous vehicles and smart road scenarios • Digital Twins; Offloading; HPC; Critical Infrastructures • HPC, Energy, Cultural Heritage • Security, mobility, use case LOI • Integration design with next-generation networks for a standardized IT architecture to provide Edge Cloud Services, in Spain, aligned with similar Continuum projects in Europe. Edge node	IT

RO	Participating undertakings	Topics concerned/ Scope of the Collaboration	Member State
		blueprints	
Fondazione Bruno Kessler	TIM, Reply, Fincantieri, Engineering, Arsys	• AI/ML; Federation & multicloud • Collaboration on providing requirements and defining an interface to manage security services for the development of 3rd party interconnect functionality within the "Cloud computing @edge for data network services over FTTX-ORAN and ASP4AGV" project; Collaboration on optimization of AI algorithms on constraint Edge device for fleet coordination of autonomous vehicles (autonomous core services) • Edge Intelligence (Artificial Intelligence on teh Edge); Energy and Resource Aware AI; Cybersecurity • Computing, Cybersecurity	IT
Fondazione LINKS	TIM, Arsys	Collaborations and research activities about smart applications/mobility support services	IT
Gdansk University of Technology	Engineering, Arsys	Computing, AI	PL

RO	Participating undertakings	Topics concerned/ Scope of the Collaboration	Member State
INRIA	Orange, Atos	• Software power metering Power API solution and development of new features for PowerAPI • Limited to a specific project on Green Cloud • Atos has signed a strategic partnership agreement with this organizations to work on several areas of innovation; cloud architecture of trust, the development of the "cloud-edge" continuum with solutions for distributing data as well as processing capacities between operational technologies, IT technologies and cloud.	FR
Kungliga Tekniska Högskolan,	Leaseweb	Cloud, API's, Cloud-Edge, Containerised infrastructure and Container Development, Object Storage, Load Balancing and Firewalling services, as well as scalable Database production services.	SE
University of Lille	Orange	Collaboration on formally proven isolation issues with the laboratory	FR
FH (Fachhochschule) -Dortmund University	Telefónica	Collaboration about collecting QoS information from the European Edge-Cloud Continuum	DE

RO	Participating undertakings	Topics concerned/ Scope of the Collaboration	Member State
Universidad Carlos III de Madrid	Open Nebula	Research on distributed network services for interoperability	ES
ENS Université Paris Saclay	Atos	Collaboration on several areas of innovation, e.g.: cloud architecture of trust, the development of the "cloud-edge" continuum with solutions for distributing data as well as processing capacities between operational technologies, IT technologies and cloud.	FR
TU Berlin	DTAG	Ecosystems, cloud / edge, 5G/6G or data and cyber security	DE
Fraunhofer Institute for Manufacturing Engineering and Automation	Siemens	Organisation of demos/workshops to experiment on industrial edge technology and to implement edge digitalization application scenarios	DE
Technische Universität Dresden	SAP	PhD thesis with topic: Improving scheduling in large-scale Kubernetes environments.	DE
University of Pécs	4iG	Presentation of the DTS platform and its potential to raise professional interest and provide research topics that will lead to publications	HU
Gdańsk University of Technology	Atende	Collaboration on the university's project "Cloud based engineering of versatile intelligent services for various application domains"	PL

RO	Participating undertakings	Topics concerned/ Scope of the Collaboration	Member State
Valencia Polytechnic University	CloudFerro	Funding PhD/Master theses in computer science	PL
Wrocław University of Science and Technology	Oktawave	Next Gen Cloud services	PL
KU Leuven	E-group	AI and confidential AI applied research	BE
Sapienza Università di Roma	Tiscali	Innovative Solutions for AI Advanced Applications (novel AI methodologies, tools, and techniques that can be applied in diverse areas such as healthcare, education, transportation, and entertainment)	IT

Table 3 - Non-exhaustive network of ROs, benefitting from spillover effects with direct participants

2.6.1.4. Dissemination and spillovers through publications in scientific journals

(162) The participating undertakings will, over the course of IPCEI CIS, disseminate their research results in various scientific peer reviewed journals either Europe-wide and/or globally. A non-exhaustive list of examples of scientific journals, includes the following:

Journal Title	Participating undertakings	Topics covered (examples)	Years
Journal of Cloud Computing	Atende, Fincantieri Open Nebula, TIM, Tiscali, DTAG	• Performance evaluation of range-based noSQL database (2030) • Digital Twin Digital Lifecycle Management 5.0 • Progress beyond the state of the art in the research areas of security, sustainability, orchestration and advanced data	2024, 2025, 2026, 2027

Journal Title	Participating undertakings	Topics covered (examples)	Years
		processing enablement. • Artificial Intelligence	
European Blockchain Center Publications	4iG	Importance of blockchain in data authentication	2025, 2027
IEEE Transactions on Digital Twins/others	Engineering	A set of publications focusing on the experience and the approach in managing data in different operational contexts. It is planned to deliver more than one paper on the subject. Example of papers (title): "the AVANT platforms. open-source Digital twin in the continuum".	2025-2028
IEEE Transactions on Cloud Computing	Fincantieri, Open Nebula, E-Group, DTAG, Oktawave	Digital Twin Digital Lifecycle Management 5.0 Progress beyond the state of the art in the research areas of automation, software-defined overlays, and infrastructure services for distributed cloud and edge Trustworthy data and AI security box Federated cloud-edge AI framework Cloud, Edge Cloud, Orchestration & Federation	2024, 2025, 2026, 2027
Cyberun	Atos	Cybersecurity	2022, 2023 and onwards
IEEE Intelligent Transportation Systems Magazine	Fincantieri, Reply	Digital Twin Cybersecurity Autonomous Applications – Simulation & training services	2024, 2025, 2027
IEEE Internet	Open Nebula	Progress beyond the state of	2024, 2025,

Journal Title	Participating undertakings	Topics covered (examples)	Years
Computing		the art in the research area of architectures for DC-Cloud-Edge continuum management and operation	2026, 2027
International Journal of Vehicle Autonomous Systems (JVAS)	Reply	Autonomous Vehicle Collaboration Platform	2024, 2025
International Journal of Energy Research (IJER)	Orange	Energy efficient data centre Energy efficient software	2024-2026
Journal of Artificial Intelligence Research (JAIR)	Tiscali	The Process and Potential of Democratising AI: Designing User-Friendly, Open-source Frameworks for Seamless Integration and Collaboration between Humans and AI	2024
Journal of Parallel and Distributed Computing	E-Group	Review on Federated cloud-edge AI Green Processing to data framework Federated cloud-edge AI continuum optimization	2024, 2025, 2027
Journal of Cloud Computing: Advances, Systems and Applications	DTAG, Oktawave	• Cloud, Edge Cloud, Orchestration & Federation • Next generation cloud and how it will work	2024 – 2026
ACM Transactions on Embedded Computing Systems	Siemens	Integration of Cloud-Edge-Continuum with industrial embedded edge computing	2027
IEEE Computing Edge magazine	TIM	Management solutions for a multi-cloud environment	2027
Data Center Dynamics	Arys	Data centre digital twin	2027
IEEE Networks	Telefonica	Presentation of Telefonica's project and its contribution to improving edge connectivity, bringing new	2026

Journal Title	Participating undertakings	Topics covered (examples)	Years
		solutions to optimize the communication of users, edge nodes and cloud data centres.	

Table 4 - Non-exhaustive list of scientific journals

2.6.1.5. Dissemination and spillovers through training events

(163) The participating undertakings have committed to organise educational academic dissemination through dedicated training of professionals and researchers. The envisaged activities follow up on the R&D&I of new tools, products, and technologies under IPCEI CIS, covering both individual elements developed within the IPCEI, as well as wider, more comprehensive aspects and capabilities of the Multi Provider Cloud Edge Continuum. These activities aim at enhancing the skills of the individuals involved, while also promoting the capabilities enabled by IPCEI CIS and disseminating them into the scientific, academic and professional communities.

(164) The training activities will cover a broad range of formats, such as regular series of tutorials and hands-on technical trainings, workshops, webinars, hackathons, exchange programmes and internships and will cover various issues, such as: description of the architecture and of the use case solutions, reporting on successful use cases and proofs of concepts, AI/ML for green mobility services, Industry 4.0 and 5.0 applications for autonomous vehicles and smart road scenarios, employment of digital twins in the optimisation of infrastructure, integration of the newly developed blueprints into existing devices and equipment, use and capabilities of AI on the edge (edge intelligence), container development and containerised infrastructure. Some additional examples are provided in Section 2.6.3, as many of these dedicated activities are related to the release of open-source software. Each of the training activities that a direct participant has committed to provide is set out in more detail in its respective individual project portfolio.

2.6.2. Positive spillover effects of results that are protected by IP rights

(165) All direct participants have committed to disseminate the IP-protected results achieved through their individual projects under IPCEI CIS on fair, reasonable, and non-discriminatory terms ("FRAND"). For the individual projects engaged in open-source software and strategy, this commitment is in addition to the specifications and commitments in relation to their open-source strategy, which is described in Section 2.6.3.

2.6.3. Positive spillover effects related to the release of open-source software

(166) 15 out of 19 direct participants in IPCEI CIS develop, in their individual projects, open-source software: Atos, Arsys, CloudFerro, DTAG, E-Group, Engineering, Leaseweb, Oktawave, OpenNebula, Orange, Reply, SAP, Siemens, TIM, and Tiscali. This type of software, once developed, is published in a public repository. Such repository is open and freely accessible to any interested user, who can, in

turn, use and further modify the software. After publishing it in the repository, the initial developer of open-source software usually undertakes promotion and/or training activities, in order to advertise its software, highlight its individual characteristics and enhance its usability by other parties. Such wide access and usability are inherent into the nature and characteristics of open-source software. This is the typical behaviour when creating open-source software, to which all affected direct participants will standardly adhere.

(167) In the context of IPCEI CIS, the Member States submit that all direct participants employing open-source software commit to undertake specific additional actions, reaching further than what they would normally do under their usual business practices. These additional and more far-reaching activities aim at ensuring a wide dissemination of the positive results of the individual projects, as well as of the integrated project (to the extent it is based on open-source software), not only to the specialised audience of software developers, but also more widely to a bigger pool of users, to economy and to society (including to undertakings, individuals and Member States not participating in IPCEI CIS). Thus, these actions aim at generating further positive spillover effects of the open-source model that is being employed.

(168) In particular, the Member States commit to specific actions centred around four pillars: (a) the type of license that will be used for the open-source software; (b) the open source community that the direct participant will be active in and its governance model; (c) concrete actions regarding: the community, the competitors and the users of the software; (d) additionality compared to the usual business practices that would have been followed, in the absence of these commitments.

Type of license

(169) The publication of open-source software in the repositories in principle can happen under different types of licenses. In IPCEI CIS, the Member States commit that all direct participants employing open-source software will make it available through the use of permissive non-restrictive licenses. This type of license allows wide use of the software, including also modification and proprietisation; it has only marginal limitations on the further use of the original software and of the derivative or future versions. Most notably, it does not include limitations as to the publication or exploitation of the modified source code; therefore, any derivative or future version of the source code can be published/exploited under any type of license, even proprietary ([29]). As such, permissive licenses offer significant flexibility and allow additional development and/or further exploitation of the source code depending on the developers' business needs and model. In that way, permissive licenses make the source code attractive to other developers, users and competitors, while also encouraging and

([29]) Other types of licenses are, for example, copyleft (protective) licenses or licenses for non-commercial use. Copyleft licenses permit propietisation of derivative or future versions of the source code, provided that the latter are published/exploited under copyleft licenses as well (contrary to permissive licenses which do not include such limitation). Licenses for non-commercial use forbid the use of the modified source code for the generation of profit.

incentivising its further development and use. The most widely used types of permissive licenses are MIT, BSD and Apache ([30]).

Open-source communities and governance models

(170) The Member States submit that the direct participants will actively participate in open-source communities ([31]). Depending on the subject-matter of the individual projects and on the most suitable channel to promote the software, direct participants will either contribute to existing open-source communities or will establish new ones and contribute therein. For example, Atos, CloudFerro, Engineering, OpenNebula, Reply, SAP, Siemens, TIM will contribute to such existing communities, for instance the ones of Linux Foundation, Cloud Native Computing Foundation, TM Forum, Fiware, Eclipse Foundation. Other direct participants, such as DTAG, E-Group and Leaseweb aim at establishing new open-source communities where they will contribute.

(171) As regards the governance model, direct participants which will contribute to existing communities commit to abide by the rules of those communities. The direct participants which aim at establishing new community commit to do so by setting governance rules that will be in line with the IPCEI objectives and structure, including its governance bodies and rules. Under both existing and new open-source communities, all direct participants commit to abide by rules ensuring equal treatment of all community members, sharing the source code and relevant know-how with everyone (both participants in the IPCEI and not).

Concrete actions regarding the communities, users and competitors

(172) The direct participants will undertake specific activities, with different target audiences: the open-source communities (including all their members), the direct participants' competitors and the users of the open-source software. As regards certain actions, it is likely that their target audiences may overlap as, for instance, competitors and users may also be members of the open-source community. The direct participants presented concrete and identifiable actions that go beyond what is required by the individual projects, while also explaining how these actions are additional and different to what they would do in the absence of IPCEI CIS.

(173) These actions include:

(a) Towards the open-source community:

- Community building and active engagement: either in existing or new open-source communities: the direct

([30]) While all belonging to the category of permissive licenses, these three types may entail differences to each other. For instance, intellectual property under an MIT license can be used in any way as long as the licenses and original copyright from the original software are included in the derived code. Apache allows to reproduce, distribute, modify and use the software for commercial use as long as the required licenses notices are provided. BSD licenses allow proprietary software developers to use, modify, and distribute the source code as long as they keep the license notices and references intact.

([31]) An open-source community is an online community, consisting of individual programmers and/or companies, where different parties can work collaboratively on open-source projects. These communities typically have certain governance rules, to enable collaboration between numerous parties.

participants commit to play an active role therein, by ensuring equal and non-discriminatory access to all community members, fostering membership, providing mentorship and support, as well as actively engaging new contributors. The direct participants will also establish (if applicable) and enforce governance rules within the community. They intend to establish recognition and reward systems, in order to incentivise further innovation and attract new members (including focusing on SMEs).

- Prepare and provide supporting material and services: the direct participants will provide coherent technical documentation (e.g. manuals, starter kits) of the developed open-source solutions and training (e.g. webinars, workshops, tutorials, onboarding sessions), in order to familiarise other members of the community with the open-source software. They will also provide technical support services, as well as access to a testing environment, which will enable other community members to test the software, including potentially new solutions developed on the basis of such software. Thus, the community members will be able to use and further develop the software.

- Organise events in the community: the undertakings intend to actively pursue events, such as open discussion groups, presentations, bootcamps and hackathons. In that way, the community members will direct participants will provide the environment and the possibility to instigate collaborations and new innovative ideas by any interested party.

- Engage in broad dissemination actions in relation to the community: some direct participants intend to undertake collaborations with research organisations and to engage in further dissemination actions through organising competence centres. These actions will further strengthen and propagate the positive results of the open-source software developed within IPCEI CIS.

(b) Towards competitors:

- Maintain open and non-discriminatory approach towards competitors: the direct participants intend to adopt an open, fair and equal stance as regards their competitors by not excluding them from any dissemination and promotion action. They will also remain open to potential collaborations, as well as to recruiting new contributors.

- Prepare and provide technical material and services: similarly to what is mentioned above regarding the community, the direct participants will provide technical documentation,

trainings and support in order to enable competitors to use and further develop the open-source software.

- Organise events and hackathons: similarly to what is mentioned above regarding the community, the direct participants also commit to organise events engaging also their competitors, such as conferences, bootcamps, hackathons, code challenges. These environments can incentivise the exchange of ideas and thus provide suitable circumstances for further innovation, on the basis of the open-source software.

- Engage in broad dissemination actions encompassing competitors: similarly to what is mentioned above regarding the community, the direct participants intend to organise and participate in wide-ranging events addressing the industry. They will reach out to other undertakings active in the sector and promote the solutions available through the open-source software, thus enhancing the use and disseminating the possibilities of the software.

(c) Towards the users / customers:

- Prepare and provide technical support and related services: similarly to what is mentioned above regarding the community and competitors, the direct participants will also offer training material (documentation and services) to their customers, in order to familiarise them with their products and to enable them to use the open-source software efficiently, as well as to support early adopters. Moreover, they intend to provide auxiliary services in relation to the product, thus facilitating even more the overall user experience, such as testing, consulting and administrative services.

Additionality

(174) The Member States submit that the activities described above constitute an "extra effort" for the direct participants concerned as these go beyond the typical open-source-related behaviour and the participants' usual business practices. In addition to strengthening the open-source communities with additional contributors (i.e. the direct participants that were not engaged with this model before this IPCEI), undertaking the activities described in recital (173) represents an additional effort and investment of resources, that would not have taken place in their usual conduct of business.

2.6.4. Positive spillover effects from the R&D&I and FID phase: access to infrastructure elements

(175) 14 of the individual projects include setting up of physical infrastructure elements or laboratories, which are necessary to perform R&D&I and FID activities of the development and deployment of software (e.g. on edge nodes, servers, on-premises installations). These are the individual projects of the direct participants: Arsys, Atos, DTAG, Telefónica, 4iG, E-Group, Tiscali, Fincantieri, Reply, TIM, Leaseweb, CloudFerro, Open Nebula, Oktawave.

(176) The direct participants (concerned commit to provide, in principle, open and non-discriminatory access to the R&D&I and FID physical infrastructure elements or laboratories to any third party that may be interested, either participating in the IPCEI or not ([32]). Access will be granted to at least 20% of the annual capacity of the infrastructure elements concerned by the individual project ([33]) on an average annual basis. Interested third parties, including competitors of the direct participants, will be able to use the infrastructure elements concerned for the purposes of their own research and testing activities. This will allow other undertakings to develop and test their own software / solutions on infrastructure elements and laboratories that they do not have available themselves. This commitment includes providing access to the supported infrastructure elements for free, and in principle for the whole duration of the projects of the direct participants. The direct participants concerned will also undertake promoting activities, in order to advertise this possibility to other undertakings and thus attract interested parties.

(177) In addition, some direct participants will also provide support in the form of documentation, guidance material, hands-on trainings, in order to offer instructions and facilitate the use of the infrastructure by parties unfamiliar with it.

(178) Certain direct participants have committed to providing a digital, online live demo of the project results. Such online version will effectively act as a mechanism to discover the product features and capacities. Those direct participants will attract interested third parties to make use of this possibility, by promoting it, communicating and contacting potentially interested users.

2.6.5. Positive spillover effects from the FID phase: use cases

(179) Almost all individual projects of IPCEI CIS (18 out of 19) include testing and validation of the developed software solutions in real-life conditions in specific economic sectors by developing so-called use cases. Such use cases form part of and are performed for the purposes of the individual projects and thus target sectors that are most relevant for the individual project. The direct participants have committed, as a spillover, to produce self-standing technical material, to perform reference business case studies, and to organise trainings for alternative/additional economic sectors that they have to identify. In this way the undertakings and professionals active in such alternative sectors will be able to adapt the use cases into solutions for other sectors and thus make use of the knowledge and skills generated during the aided individual projects.

(180) By way of example, some of the sectors that are additionally targeted by this spillover commitment (different from the sectors in which the original use cases of the respective project were located) are: agriculture, smart cities and building applications, transportation, utilities and critical infrastructure, media and

([32]) The direct participants will follow fair, transparent and non-discriminatory criteria when allowing third parties to access their physical infrastructure elements. For instance, certain participants plan to organise open calls for interest, while others plan to organise a targeted portal, where third parties may indicate their interest, or engage in promotion activities through their website, platforms.

([33]) The percentage may range, in some cases it is the minimum, i.e. 20%, while in some other cases it is higher (e.g. 30%) or even reaching 100%.

entertainment, transport, emergency services, financial services and retail, industrial automation, robotics, healthcare and hospitality, logistics and education.

(181) Each individual project ensured that the sectors targeted by the spillovers commitment are different from and genuinely additional to those originally included in the scope of the project.

2.6.6. Dissemination and positive spillover effects to the indirect partners

(182) The Member States submit that the participating undertakings will collaborate with many of the 90 indirect partners to achieve the objectives of their individual projects, as well as those of the four WS of IPCEI CIS. As a result of these collaborations, the benefits of IPCEI CIS would not be limited to the participating undertakings but would be extended to other undertakings and ROs, many of which participated initially in the design of IPCEI CIS and will participate, according to their funding Member States, to its ecosystem with its own individual project (see recital (61)). The following examples, submitted by the Member States, are illustrative of the various collaborations and objectives pursued:

- The collaboration between OpenNebula and Data Vaccinator (LU) aims to support the development of innovative capabilities for secure data anonymization in cloud-edge environments following a data-privacy-by-design approach. Furthermore, Open Nebula and Data Vaccinator will jointly work on the certification and delivery of a Proof of Concept (PoC) on a cloud-edge meta-orchestrator platform.

- Engineering and ENGIE Laborelec (BE) have agreed to collaborate on the definition of a common catalogue of algorithms for electric vehicles (provided by ENGIE), adequate datasets (along the continuum) and associated metadata (enhancing portability and reusability), to test and validate them in the platform focused on energy provided by Engineering.

- The cooperation between DTAG and Infobip (HR) will focus on the development of the next generation of advanced technological data processing capabilities, energy efficiency, high security, privacy and data protection for Next Generation Cloud Infrastructure and Services. DTAG will focus on the infrastructure domain, while Infobip will contribute to the service domain. The partnership between DTAG and Infobip will enable faster data transfer, intelligent data processing, and a more efficient production process with less energy consumption.

- TIM and Result (SL) will jointly work on the improvement of data processing and transformation of multi-domain data sources in support of AI/ML enabled provisioning and assurance and the application of federated learning in multi-domain performance analysis and prediction with distributed data collection and processing including edge cloud and terminals.

- The cooperation between Engineering and SIA Dati Group (LV) aims to achieve the realization of digital twins. Engineering will focus on the aspects of data fusion based on AI, while Dati Group will provide knowledge on transactions between entities and data anonymization techniques.

- SAP and Amadeus (FR) will jointly work on the development of data exchange capabilities in a distributed edge data processing context. SAP will work on developing an open reference architecture for the Multi Provider Cloud Edge Continuum. Amadeus will focus on various aspects of decentralized data exchange by providing technical capabilities to manage the distributed data exchange, while SAP will develop solutions to ensure the security and integrity of the exchanged data.

- The cooperation between E-Group and Gdansk University of Technology (PL) aims to support the ML Options practice in the experimentation and development of ML models, including production, testing, versioning, continuous delivery, and monitoring in the edge-cloud-continuum of multiple data users and producers and is expected to develop the "assembly and test" service for delivering cloud products for intelligent analysis of content (text, images).

- The collaboration between Leaseweb and Gigas Hosting (ES) targets the creation of more energy efficient and carbon neutral cloud facilities by developing systems to consume data centre metrics and API's that can adjust power consumption and compute usage in the IaaS, CaaS and PaaS platforms.

2.7. The aid measures

2.7.1. Total eligible costs in IPCEI CIS

(183) The notifying Member States also submit that the total IPCEI CIS eligible costs ([34]) are approximately EUR 1.6 billion.

2.7.2. Aid amounts per participating undertaking and per Member State

(184) The Member States have submitted the amounts of State aid under the measures that they plan to provide to the participating undertakings, together with the individual eligible costs and funding gaps. The funding gaps submitted by the Member States consist of the difference between the positive and negative cash flows over the lifetime of the investment, discounted to their current value on the basis of an appropriate discount factor reflecting the rate of return necessary for the beneficiary to carry out the project, notably in view of the risks involved.

(185) According to point 33 of the IPCEI Communication, the maximum permitted aid level is determined with regard to the identified funding gap in relation to the eligible costs. That implies that if justified by the funding gap analysis, the aid could cover all of the eligible costs. However, the nominal aid amount shall not exceed the eligible costs. Moreover, in some cases, Member States may choose to disburse State aid in several instalments over a certain period of time during the life span of a project. In such cases, aid payable in the future, including aid payable in several instalments, shall therefore be discounted (using the weighted average cost of capital ("WACC") as a discount factor), to its value at the

([34]) Eligible costs are only those costs of the individual projects that comply with the requirements of the Annex to the IPCEI Communication. They, however, do not represent all costs required to conduct the R&D&I and FID activities concerned. The remaining portion of the costs required to conduct those activities, which are not considered eligible for public financing, will be absorbed by the participating undertakings.

moment it is granted. This discounted value of all the aid instalments shall then not exceed the notified funding gap (which is itself discounted). Thus, the notified aid amounts can therefore not exceed the minimum of either in discounted terms the funding gap and in nominal terms the eligible costs (as reported in section 2.7.2).

(186) The main parameters for determining the State aid level are expressed in the Tables 4 to 11 in nominal and in discounted NPV terms.

		Million euro			
	Undertaking	**Eligible Costs (nominal)**	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**Atos**	[50 - 60] *	- [10 - 20]	19.53	[10 - 20]
2.	**Orange**	[40 - 50]	- [20 - 30]	20.00	[10 - 20]
Total		100.87	-37.54	39.53	36.54

Table 5 - France - State aid in million EUR

		Million euro			
	Undertaking	**Eligible Costs (nominal)**	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**DTAG**	85.71	- [60 – 70]	68.73	61.29
2.	**SAP**	353.64	-275.93	329.9	275.93
3.	**Siemens**	65.48	-31.04	38.18	31.04
Total		504.83	-368.95	436.81	368.26

Table 6 - Germany - State aid in million EUR

		Million euro			
	Undertaking	**Eligible Costs (nominal)**	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**4iG**	[0 – 10]	- [0 - 10]	6.48	[0 – 10]
2.	**E-Group**	[90 - 100]	- [40 - 50]	60.30	[40 – 50]
Total		106.81	-46.12	66.78	46.10

Table 7 - Hungary - State aid in million EUR

		Million euro			
	Undertaking	**Eligible Costs (nominal)**	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**Engineering**	112.46	-72.52	82.56	72.14
2.	**Fincantieri**	[40 - 50]	- [20 - 30]	30.85	[20 - 30]
3.	**Reply**	[100 - 200]	- [100 - 200]	118.92	[100 - 200]
4.	**TIM**	[100 - 200]	- [80 - 90]	103.99	[80 - 90]
5.	**Tiscali**	[90 - 100]	- [60 - 70]	72.96	[60 - 70]
Total		541.93	-351.90	409.28	351.52

Table 8 - Italy - State aid in million EUR

* *Covered by the obligation of professional secrecy*

	Undertaking	*Million euro*			
		Eligible Costs (nominal)	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**Leaseweb**	- [80-90]	- [40-50]	60.50	[40-50]
Total		- [80-90]	- [40-50]	60.50	[40-50]

Table 9 - Netherlands - State aid in million EUR

	Undertaking	*Million euro*			
		Eligible Costs (nominal)	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**Atende**	5.48	-4.27	4.27	3.57
2.	**CloudFerro**	28.24	-19.21	21.80	19.21
3.	**Oktawave**	13.16	-8.50	10.40	8.45
Total		46.88	-31.98	36.47	31.23

Table 10 - Poland - State aid in million EUR

	Undertaking	*Million euro*			
		Eligible Costs (nominal)	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
1.	**Arsys**	[20-30]	- [1-10]	11.41	[1-10]
2.	**Open Nebula**	[20-30]	- [10-20]	20.29	[10-20]
3.	**Telefónica**	[100-200]	- [100-200]	155.05	[100-200]
Total		215.13	-171.86	186.75	171.86

Table 11 - Spain - State aid in million EUR

	Million euro			
	Eligible Costs (nominal)	**Funding Gap (NPV)**	**State aid (nominal)**	**State aid (discounted/NPV)**
Total IPCEI CIS	1599.63	-1049.44	1236.12	1047.10

Table 12 - All Member States - State aid in million EUR

(187) The overall notified State aid is thus around EUR 1.2 billion in nominal terms and around EUR 1 billion in discounted terms.

(188) The Member States submit that the durations of the individual projects of the participating undertakings differ. The eligibility period (i.e., the period during which the costs that the undertakings can claim as eligible, should be incurred) is the following, per WS:

WS	Start date ([35])	End date
1 Cloud edge	This WS starts at the earliest in Q4 2023.	The last eligible year during the FID phase is planned at the latest in Q1 2028.

([35]) Some undertakings already started works at their own risk, before the Commission's approval of the State aid measure but after having submitted an application for State aid to the national authorities.

continuum infrastructure		
2 Cloud edge capabilities	This WS started at the earliest in Q1 2023.	The last eligible year during the FID phase is planned at the latest Q4 2031.
3 Advanced processing tools and services)	This WS starts at the earliest in Q4 2023.	The last eligible year during the FID phase is planned at the latest Q4 2028.
4 Advanced applications	This WS starts at the earliest in Q4 2023.	The last eligible year during the FID phase is planned at the latest Q3 2029.

Table 13 - IPCEI CIS costs eligibility period

2.7.3. The aid instruments

(189) The aid to be granted by all Member States will take the form of direct grants.

2.8. Granting of the aid under the notified measures

(190) All Member States participating in IPCEI CIS have subjected the granting of State aid to the prior approval of the Commission.

(191) Pursuant to point 10 (a) of the IPCEI Communication, the Member States have further confirmed that the participating undertakings are not undertakings in difficulty as defined in the Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty ([36]).

(192) The Member States have furthermore committed to suspend the granting of the notified aid if the beneficiary still has at its disposal earlier unlawful aid that was declared incompatible by a Commission Decision (either as individual aid or aid under an aid scheme having been declared incompatible), until that beneficiary has reimbursed or paid into a blocked account the total amount of unlawful and incompatible aid and the corresponding recovery interest, pursuant to point 10 (b) of the IPCEI Communication.

(193) The Member States have also confirmed that aid under IPCEI CIS will not be granted to the participating undertakings if it constitutes by itself, by virtue of the conditions attached to it or of its financing method, a non-severable violation of Union law, pursuant to point 10 (c) of the IPCEI Communication, in particular:

(a) granting of aid that is subject to the obligation for the beneficiary to have its headquarters in the Member State concerned or to be predominantly established in that Member State,

([36]) Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty (OJ C 249, 31.7.2014, p. 1).

(b) granting of aid that is subject to the obligation for the beneficiary to use nationally produced goods or national services,

(c) aid restricting the possibility for the beneficiary to use the obtained R&D&I results in other Member States.

(194) Finally, the Member States have indicated that cumulation with other aid, de minimis aid ([37]) or Union funding will be allowed to cover the same eligible costs, provided that the total amount of public funding granted in relation to the same eligible costs does not exceed the most favourable funding rate laid down in the applicable rules of Union law, pursuant to point 35 of the IPCEI Communication.

2.9. Claw-back mechanism

(195) In order to further ensure that the aid is kept to the minimum necessary, the Member States have in their notification committed to introduce a claw-back mechanism, pursuant to point 36 of the IPCEI Communication. The basis for the claw-back mechanism will be ex post figures, which have been subject to annual approval by an independent auditor. For this purpose, separate analytical accounting will be required from the participating undertakings in the relevant Member State. The detailed conditions of the claw-back mechanism are attached in Annex I to this Decision.

(196) The claw-back mechanism for the individual projects of the participating undertakings only applies in case of a "Surplus", i.e. when the net present value (using the WACC of the individual project as the discount factor) of the actual cash flows of the project including the actual State aid disbursements is strictly positive, as defined in Annex I to this Decision. The claw-back mechanism then consists in the repayment by the beneficiary of a State Share, which is essentially determined as the lower of the aid intensity or 75 % of any potential Surplus. This ensures that the beneficiaries have an incentive to deliver their project in an efficient manner, as, depending on the aid intensity of the individual project, a share of at least 25% of any potential Surplus will remain with the participating undertakings.

(197) The claw-back mechanism will apply to participating undertakings having a notified nominal aid amount, per Member State, above EUR 50 million ([38]). This threshold covers 9 out of the 19 projects, and more than 85% of the total aid. Thus, the claw back shall ensure that the participating projects obtaining a significant amount of aid will be subject to this mechanism, while at the same

([37]) Commission Regulation (EU) No 1407/2013 of 18 December 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to de minimis aid (OJ L 352, 24.12.2013, p. 1).

([38]) Similar SA.101202 (2023/N) and others – Important Project of Common European Interest on Microelectronics/Communication Technologies (IPCEI ME/CT), SA.54794 (2019/N) and others - Important Project of Common European Interest (IPCEI) on Batteries, recital 196 (OJ C 292, 29.7.2022, p. 1); SA.55831 (2020/N) and others - Important Project of Common European Interest on European Battery Innovation (EuBatIn), recital 315 (not yet published); SA.64625 (2022/N) and others – Important Project of Common European Interest on Hydrogen Technology (Hy2Tech), recital 284 (not yet published); and SA.64631 (2022/N) and others – Important Project of Common European Interest on Hydrogen Industry (Hy2Use), recital 166 (not yet published).

time avoiding burdensome administrative obligations on the relatively smaller projects.

(198) The Member States are required to report to the Commission on the implementation of the claw-back mechanism within two months after each application of that mechanism.

2.10. Transparency

(199) In their notification, the Member States have committed to comply with the transparency and publication requirements of points 48 and 49 of the IPCEI Communication. In particular, the Member States have committed to publish in the Commission's transparency award module or on a comprehensive State aid website, at national or regional level, the full text of the individual aid granting decision and its implementing provisions or a link to it, as well as all related information as specified in point 48 of the IPCEI Communication ([39]). In addition, the Member States will provide annually a summary report of the undertakings' execution of their activities, as well as on the progress of IPCEI CIS as a whole to the Commission.

(200) Moreover, the Member States have explained that the direct participants will be subject to a reporting obligation towards the competent national authorities. Such reporting will take place on the basis of a reporting template, which will be developed jointly by the Member States and the Commission, and will cover the execution of the individual projects, and in particular aspects such as the technological advancements, progress on R&D&I and FID deliverables, spillover effects, etc.

3. ASSESSMENT OF THE MEASURES

3.1. Presence of State aid pursuant to Article 107(1) TFEU

(201) According to Article 107(1) TFEU, "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market".

(202) In order to qualify as State aid under Article 107(1) TFEU, the following cumulative conditions must be met: (i) the measure must be imputable to the State and financed through State resources; (ii) it must confer an advantage on its recipient; (iii) that advantage must be selective; and (iv) the measure must distort or threaten to distort competition and affect trade between Member States.

([39]) The Member States have notified the following websites for this purpose: https://www.europe-en-france.gouv.fr/fr (France), https://foerderportal.bund.de/foekat/jsp/SucheAction.do;jsessionid=79091C4B4345D0302505F19CB3F0A84F?actionMode=searchmask (Germany), https://nkfih.gov.hu/ (Hungary), https://www.rna.gov.it/sites/PortaleRNA/it_IT/home (Italy), https://www.rvo.nl/subsidies-financiering/ipcei (the Netherlands), https://sudop.uokik.gov.pl/ (Poland), https://planderecuperacion.gob.es/ and https://portal.mineco.gob.es/es-es/ministerio/PlanRecuperacion/Paginas/Recuperacion_Transformacion_Resiliencia.aspx (Spain).

(203) The public support measures of the Member States will be financed with funds stemming from the respective State budgets. The measures therefore involve State resources and are imputable to the relevant Member States.

(204) The measures in the form of direct grants to the participating undertakings will relieve the recipients of costs that they would have had to bear themselves under normal market conditions. By contributing to the financing of the R&D&I and FID activities with funds that would not have been obtained under normal market conditions, the aid measures confer an economic advantage on the aid beneficiaries over their competitors. These measures are granted only to the aid beneficiaries listed in section 2.3.3 with respect to their individual projects. The aid measures are therefore selective.

(205) The aid beneficiaries involved in the relevant WS described above in section 2.3.2, operate in different domains of the cloud and edge computing field, for example management of data centres, provision of cloud services and applications, in particular IaaS and SaaS, as well as of specific applications either for business (business-to-business solutions) or individual customers (business-to-customers). These are economic sectors open to intra-Union trade, both in terms of supply and demand. Therefore, the measures are liable to distort or threaten to distort competition and intra-Union trade, since they improve the competitive position of the beneficiaries compared to other undertakings with which they compete.

(206) In light of the foregoing, the public support granted to the participating undertakings in the form of direct grants, as described within the framework of IPCEI CIS, qualifies as State aid within the meaning of Article 107(1) TFEU.

3.2. Legality of the aid measures

(207) The Member States submit that they shall not grant State aid to any of the participating undertakings before the notification of the Commission's decision approving aid for the execution of IPCEI CIS. The granting of State aid will be governed by national funding agreements that are expected to be concluded following the Commission's decision (see recital (190)). By notifying the measures before putting them into effect, the Member States have fulfilled their obligations under Article 108(3) TFEU.

3.3. Assessment of the aid measures

3.3.1. Applicable legal basis for assessment

(208) In derogation from the general prohibition of State aid laid down in Article 107(1) TFEU, aid may be declared compatible by the Commission if it can benefit from one of the derogations enumerated in Article 107(2) and (3) TFEU.

(209) The Commission will assess the compatibility of the notified measures on the basis of Article 107(3)(b) TFEU, which concerns aid to promote the execution of an IPCEI. The criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of IPCEIs are laid down in the IPCEI Communication. The Commission will examine whether IPCEI CIS satisfies the conditions laid down in the IPCEI Communication in the subsequent sections, following the structure of the Communication.

3.3.2. Eligibility criteria

(210) In order to be eligible for aid under Article 107(3)(b) TFEU, the notified measures must involve a project. That project must be of common European interest, and it must be important. These three criteria are considered below.

3.3.2.1. Definition of a project

(211) According to point 13 of the IPCEI Communication "the Commission may consider eligible an 'integrated project', that is to say, a group of single projects inserted in a common structure, roadmap or programme aiming at the same objective and based on a coherent systemic approach. The individual components of the integrated project may relate to separate levels of the supply chain but must be complementary and significantly add value in their contribution towards the achievement of the important European objective".

(212) The Member States, as explained in section 2.5, consider the notified IPCEI CIS to constitute an integrated project with individual components ([40]).

(213) IPCEI CIS is designed in such a way as to contribute to the common objectives, formulated by the Member States and the participating undertakings, as described in section 2. As mentioned therein, the main aim of IPCEI CIS is to establish the first European Multi Provider Cloud Edge Continuum, which will be interoperable, accessible, sustainable and highly secure. IPCEI CIS will enable new and highly innovative capabilities, which will be openly accessible and released as open-source software. Thus, IPCEI CIS will facilitate the deployment of cloud and edge technologies across the European market and enable the even further innovation and development of the basic software layer. In turn, this will support the digital transition for the entire European market.

(214) The Commission recognises the Member States' endeavour to work together in order to build jointly, through the technical capabilities described in recital (213), the basic layer of a federated European cloud and edge services market, thus establishing an ecosystem that will strongly facilitate and accelerate the Union's digital transition. This is in line with the Union's digital targets, as also illustrated in the relevant policy documents (see recitals (222) to (230)). While the Member States have developed national digital transition strategies in the cloud and edge computing market, it is crucial to undertake joint and coordinated efforts across the EU, in order to collaboratively progress towards overcoming existing strategic dependencies, avoid fragmentation, to enhance synergies among national initiatives and to ensure technology accessibility with common core functionalities. The Commission thus considers that the joint design of IPCEI CIS contributes to aligning the Member States' specific objectives and timelines towards achieving the Union objectives.

(215) Specifically, IPCEI CIS integrates 19 individual projects based on a coherent systemic approach. The presence of this coherent systemic approach is reflected in the common planning in 2021 (see recitals (3) and (4)), prepared by the Member States, which resulted in the design of the Chapeau document. The

([40]) The Commission notes that, as is apparent from, in particular, Sections 2.2, 2.3, 2.5, 2.7.1 and 2.7.2, each of the individual projects that make up the IPCEI CIS has well-defined objectives and terms of implementation through its research deliverables, and funding needs.

Chapeau document includes an overall work plan aimed at facilitating cross-border efforts towards common objectives.

(216) In particular, the common programme established in the Chapeau document includes the definition of overall objectives at the level of IPCEI CIS (see section 2.2), articulated in specific objectives at the level of the four WS (see section 2.3.2), to be implemented and monitored under a common governance structure (see section 2.4).

(217) Furthermore, the R&D&I and FID activities within each of the four WS are grouped in different key research areas. The actions required in all key research areas included within the organisation and work plan of the four WS significantly add value for the achievement of IPCEI CIS' overall objectives (see section 2.5).

(218) As described in section 2.5, each individual project is complementary to the other projects and significantly adds value in its contribution to the achievement of IPCEI CIS' objectives. For example:

(a) the individual projects in WS 1 (Cloud Edge Continuum Infrastructure) are expected to develop the readiness of infrastructure resources, by providing tools, methodologies and by enabling the operation of cloud and edge components (e.g. edge integration and interconnection solutions, near edge computing). This infrastructure is necessary for the deployment of the Multi Provider Cloud Edge Continuum, and will constitute the basic layer, upon which the following WS and technological capabilities will be developed (see section 2.5.1);

(b) the individual projects in WS 2 (Cloud Edge Capabilities) will develop different aspects of the common reference architecture, which will serve as a blueprint for how to set up and operate a cloud and edge system. In other words, WS 2 will provide the essential software layer for the Multi Provider Cloud Edge Continuum and the individual projects will deliver on various technical capabilities (e.g. secure data processing in public cloud, storage of time-stamped data, management of multi-cloud providers, see section 2.5.2);

(c) the individual projects in WS 3 (Advanced Smart Data Processing Tools and Services) aim at developing a set of advanced cloud and edge services, which will be horizontally applicable to all users and sectors and will be deployed seamlessly across provider networks (e.g. AI models for the generation of textual and multimedia content, algorithms that enable data processing without sharing private content). This WS will contribute in particular to overcoming ecosystem-specific concepts and obstacles, which currently require substantial efforts in data transfer and processing (see section 2.5.3);

(d) the individual projects in WS 4 (Advanced Applications) aim at putting together all of the elements developed in the previous WSs and demonstrate the successful application of the Cloud Edge Continuum capabilities in sector-specific cases, for instance in shipbuilding, healthcare and industry. The demonstrations undertaken in WS 4 will serve as proof of concepts and will aim to enable the transfer of sector-specific results also to other domains (see section 2.5.4); and

(e) each WS, as illustrated in the respective sections 2.5.1 to 2.5.4 significantly adds value and is complementary to the other, thanks to the development and deployment of specific technologies, which can be used and further elaborated in the other WS (see also section 2.5.5). Each of the four WS aims to provide a different, necessary aspect for the Multi Provider Cloud Edge Continuum: WS 1 focuses on rendering the infrastructure ready for the software and capabilities enabled through the Continuum; WS 2 focuses on the common, basic software layer that will enable the capabilities from an operating perspective; WS 3 focuses on horizontal advanced applications and services, to be provided in the Continuum; WS 4 focuses on sector-specific applications, developed and tested in domains such as energy, health and shipbuilding. Moreover, the four WSs are interconnected and depend on each other: on the one hand, linearly, as each WS develops its output on the basis of the results of the previous WS ([41]). On the other hand, the WS are connected circularly, in the sense that the "first" WS (WS 1 and 2) need to take into account the capability needs of the "last" WS (WS 3 and 4), in order to ensure that their tools and technologies will be compatible with and will enable the operation of the most advanced or complex outputs. Furthermore, the complementarity between the four WS is illustrated by the fact that each WS contributes a different deliverable to the Multi Provider Cloud Edge Continuum. Each of those deliverables is different and self-standing, but they are all necessary for the successful implementation of the final, overall product.

(219) In order to ensure the coherent implementation of IPCEI CIS, the Member States will establish a common governance structure, as described in section 2.4. The governance structure will include a GA, in which all Member States taking part in IPCEI CIS will participate, and a SB, in which all participating Member States, as well as the Commission (as an observer) will be represented. IPCEI CIS' common governance structure will ensure that by joining their forces in the integrated project, the Member States will be incentivised to implement and report as planned on their individual projects, establish the planned collaborations and enable the dissemination of spillover effects in a timely manner, without jeopardising the achievement of the common objectives.

(220) In view of the above, the Commission concludes that IPCEI CIS qualifies as an integrated project in the meaning of the IPCEI Communication, as its individual projects (and the WS of which they form part) are inserted in a common programme, aiming at the same objectives and based on a coherent systemic approach. Furthermore, the individual projects and WS are complementary and significantly add value in their contribution towards the achievement of the important common objective of establishing an innovative, interoperable, openly accessible, sustainable and highly secure cloud to edge continuum.

([41]) WS 1 provides necessary infrastructure tools for WS 2; WS 2, in turn, provides the basic software that is necessary to bring the Cloud Edge Continuum capabilities into light; WS 3 builds upon this software and provides for horizontal advanced applications; WS 4 takes a step further and deploys sector-specific applications which bring all the previously developed elements together.

3.3.2.2. Common European Interest

(221) In order to establish that a project qualifies as being of common European interest, the IPCEI Communication sets out general cumulative criteria (section (a) below), as well as general positive indicators (section (b) below). In addition, the IPCEI Communication sets out certain specific criteria depending on the type of project (section (c)).

(a) General cumulative criteria (section 3.2.1 of the IPCEI Communication)

3.3.2.2.1. Important contribution to the Union's objectives

(222) According to point 14 of the IPCEI Communication, the project must represent a concrete, clear and identifiable important contribution to the Union's objectives or strategies and must have a significant impact on sustainable growth, for example by being of major importance, among others, for the European Green Deal, the European Data Strategy, the Digital Decade as well as the New Industrial Strategy for Europe and its update, the Next Generation EU, or the Union's objective to become climate neutral by 2050.

(223) In particular, the European Data Strategy ([42]) aims to reinforce the EU's data-related capabilities, by enabling decisions based on data insights, which are available to all thanks to ultra-low latency data processing services delivered by the Cloud and Edge Continuum. Furthermore, it aims at ensuring that such technologies will be secure and will comply with privacy and data protection rules for data processing activities. The European Data Strategy also encourages the establishment of a European High Impact Project to "*foster the gradual rebalancing between centralised data infrastructure in the cloud and highly distributed and smart data processing at the edge*". As a follow up to the Data Strategy, the Data Act ([43]) aims at removing the obstacles that prevent cloud users from switching between providers and using multiple providers in parallel.

(224) In its 2030 Digital Compass Communication ([44]), the Commission laid down its vision for 2030 to empower citizens and businesses through a digital transformation and enable Europe to become digitally resilient and sovereign. In this context, that Communication refers to the need for Europe to strengthen the uptake of cloud services and to deploy edge infrastructures and capabilities, while also ensuring innovative and high-quality technical results. In turn, this will allow Europe to develop the EU cloud market, by providing the opportunity to more and smaller players (including SMEs) to enter the market, thereby reducing the Union's strategic dependencies in the information and communications technology (ICT) sector.

(225) With the Digital Decade Policy Programme ([45]), the Union set out a monitoring and cooperation mechanism, among others designated to create an environment

([42]) See footnote 2.

([43]) See footnote 4.

([44]) See footnote 3.

([45]) Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Programme 2030, OJ L 323, 19.12.2022.

favourable to innovation and investment by setting a clear direction for the digital transformation of the Union and for the delivery of digital targets by 2030 (e.g., related to digital skills for population and businesses, secure, resilient, performant and sustainable digital infrastructures, digital transformation of businesses and digitalisation of public services), on the basis of measurable indicators.

(226) The Next Generation EU ([46]) stimulus package has been adopted as a temporary instrument designed to boost the recovery of Member States from the COVID-19 pandemic by addressing among others, the transition to a digital economy. The Resilience and Recovery Facility ("RRF") ([47]) for Europe constitutes a centrepiece of the Next Generation EU. The RRF Regulation requires each Member State to dedicate at least 20% of its recovery and resilience plan's ("RRP") total allocation to measures contributing to the digital transition or to addressing the challenges resulting therefrom. IPCEI CIS projects will be partly funded by the RRF.

(227) All of the above legislative initiatives supplement the Commission's Communication that sets out a European Green Deal for the Union and its citizens ([48]), where the Commission emphasised that the Union should leverage the potential of the digital transformation, as digital technologies and new methods and processes are critical enablers for reaching the European Green Deal objectives for reducing greenhouse gas emission by at least 55% by 2030, compared to 1990 levels and ensuring climate neutrality by 2050. In addition, the Green Deal Industrial Plan for Net Zero Age ([49]) calls for European standards to promote the roll-out of clean and digital technologies and provide Union industries an important competitive advantage, including at global level.

(228) IPCEI CIS will contribute to fulfilling the objectives laid down in the various Union initiatives mentioned above by:

(a) bringing together in an integrated project of 19 participating undertakings from 7 Member States, with 90 indirect partners, aiming at the creation of the first interoperable and accessible European data processing ecosystem. This ecosystem, which will comprise innovative large undertakings, SMEs, start-ups and ROs/Universities, seeks to turn the European Data Strategy into reality, by developing capabilities on data processing infrastructures, software and data sharing tools that enable the federation of energy-efficient and trustworthy cloud and edge infrastructures and related services. It will make available distributed data processing

([46]) Communication from the Commission, to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Europe's moment: Repair and Prepare for the Next Generation, COM(2020) 456 final, 27.5.2020.

([47]) Regulation (EU) 2021/41 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility, OJ L 57, 18.2.2021, p. 17-75.

([48]) Communication from the Commission, to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, The European Green Deal, COM(2019) 640 final, 11.12.2019.

([49]) Communication from the Commission, to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, A Green Deal Industrial Plan for the Net-Zero Age, COM(2023) 62 final, 1.2.2023.

technologies in a way that will guarantee access to services with low latency (few milliseconds) wherever the users are located, strengthening European data processing capacities to meet the needs of European citizens, businesses and public administrations. Thus, it will facilitate the digital transformation and enhance the uptake of cloud technologies by its users, namely European citizens, businesses and public administrations;

(b) stimulating collaborative interactions among direct participants, with the aim of developing quickly the expected technologies, by using the different technology elements required by the different collaborators (e.g., software stacks, applications, processes, etc.);

(c) providing the technological foundations which will enable a truly interoperable European Cloud Edge Continuum, thus aiming at contribution to lowering entry barriers for new service providers, in line with the objectives of the Data Act;

(d) bringing together Member States that have adopted the objectives of the Digital Decade Policy Programme within their national strategies, thus enabling them to work jointly towards these objectives and developing the technologies and solutions, which will support Europe to achieve the 2030 Digital Compass targets, notably: (i) to have "*at least 75% of EU enterprises [...] taking up cloud computing services*" and (ii) to account for "*10 000 climate neutral highly secure edge nodes deployed in the EU*";

(e) offering a structured framework to the Member States and the participating undertakings to mobilise funds from the RRF in a coordinated manner that will contribute to the digital transition or to addressing the challenges resulting therefrom;

(f) addressing the technological performance, sustainability and societal challenges of the next decade, putting emphasis on the availability and accessibility of tools and technologies to support an advanced cloud edge continuum, as well as on the reduction of energy consumption and enhanced sustainability within not only the cloud edge computing sector (i.e., edge nodes, orchestration, federation, data processing solutions) but also the communication technologies domain more widely; and

(g) ensuring that the new data processing technologies will be consistent and compliant with the Union's rules on security, privacy and data protection.

(229) As regards the contribution of IPCEI CIS to the New Industrial Strategy for Europe ([50]), IPCEI CIS supports significant investments in the Union's cloud and edge computing domain. It is expected to contribute, according to estimates provided by the Member States, to job creation: according to estimations submitted by the Member States, direct participants are expected to create 1 000 direct and indirect jobs of highly-qualified professionals (e.g. data scientists, software engineers, cloud architects, cybersecurity engineers, AI specialists) during the R&D&I and FID phases of the projects, while during the

([50]) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, A New Industrial Strategy for Europe, COM (2020) 102 final, 10.3.2020.

commercialisation phase they are expected to create up to 5 000 new employment positions. In addition, the wider ecosystem of applications that will be generated around the Multi Provider Cloud Edge Continuum will scale up the number of new jobs tenfold, as cloud investment has been observed to have a multiplier effect. For each direct job created, almost double the number of additional or indirect jobs are also created. The Commission notes that this process will also enhance and upscale the professional, educational, and technological skills in Europe, as it will foster the creation of numerous highly specialised professionals in ground-breaking and forward-looking fields.

(230) Based on the foregoing (recitals (228)to (229)), the Commission considers that IPCEI CIS will deliver on its overall objectives (see section 2.2) and contribute significantly to fostering R&D&I, especially through the substantial investments carried out by the participating undertakings and the planned collaborations. The Commission therefore concludes that IPCEI CIS will provide an important contribution, in a concrete, clear and identifiable manner, to one or more Union objectives and has in particular a significant impact on sustainable growth across the Union.

3.3.2.2.2. Important market failures

(231) According to point 15 of the IPCEI Communication, the project must demonstrate that it is designed to overcome important market or systemic failures, preventing it from being carried out to the same extent or in the same manner in the absence of the aid, or societal challenges, which would not otherwise be adequately addressed or remedied.

(232) The Member States recall that one of the envisioned policy objectives that the 2030 Digital Compass seeks to achieve is that, by 2030, EU enterprises account for 75% of cloud uptake and the deployment of 10 000 edge nodes deployed by 2030 ([51]). However, in the absence of IPCEI CIS, the market, comprised of the large hyperscalers (Amazon, Google, Microsoft) and smaller European players, will likely not deliver on this policy goal. The Member States submit that this is due to the reasons set out below.

(233) First, the hyperscalers have established their own ecosystems, which allow them to provide some proprietary edge services. In the absence of IPCEI CIS, the hyperscalers will likely have little incentive to cannibalise their own cloud profits and will thus likely not provide sufficient edge services to achieve the desired policy goal in a timely fashion. Moreover, hyperscalers have limited incentives to create an interoperable open-source standard as this reduces vendor lock-in and thus their profits. While the benefits of an open-source standard cannot be fully appropriated as in a proprietary solution, an open-source standard creates significant benefits for third parties and enhanced security due to its openness to the developer community, which works collaboratively on improvements of the code.

([51]) See footnote 3.

(234) Second, the undertakings that participate in IPCEI CIS would only provide very limited edge services in absence of this IPCEI. Since these undertakings are relatively small compared to the hyperscalers, they need to coordinate their investments so as to increase the likelihood of a successful and interoperable product and appropriate the overall benefits from their product development to ensure sufficient investment levels. The difficulty for individual players to coordinate on a common and interoperable open-source data processing environment, as well as the existence of the associated positive and negative externalities, prevent a purely market-based solution involving the participating undertakings.

(235) Third, according to the Member States, the current regulatory framework has not imposed a common standard in the data processing industry thus far. In fact, imposing such a mandatory standard might not be optimal since there is typically a lengthy adoption process compared to the life cycle of edge and cloud services. Also, there are advantages in having parallel systems that are interoperable. Moreover, self-regulatory initiatives to enhance interoperability, such as SWIPO ([52]) and its Codes of Conduct have shown insufficient effect on achieving effective interoperability and enabling cloud switching. Current regulatory provisions, which stipulate the objective of effective interoperability and cloud switching, have yet to bear effects following the entry into force of the Data Act ([53]) and the establishment of the central Union standards repository for the interoperability of data processing ([54]). Even after this repository is available, populating it remains a lengthy process and it remains unclear how effectively and during what time period cloud providers will adapt their services to be compatible with these standards in order to ensure cloud edge continuum interoperability.

(236) In light of the Member States' submissions, the Commission finds that three important market failures exist, which prevent the IPCEI CIS project from being carried out – at least to the same extent or in the same manner – in the absence of aid. First, coordination failures arise when the private profitability of innovation is conditional on other companies joining the innovative efforts at the same time. This can arise, in particular, when the development of an open-source interoperable solution requires different innovations along the continuum. There is a lack of economic incentive for the smaller market players to initiate developments alone, as it can only be profitable if these services become part of a much larger digital ecosystem with a multitude of offerings that can compete with full stack providers. This lack of coordination on a common and interoperable open-source standard has resulted in a lack of interoperability and data portability, which locks customers in with their current provider.

([52]) SWIPO (Switching Cloud Providers and Porting Data), is a multi-stakeholder group facilitated by the European Commission, in order to develop voluntary Codes of Conduct for the proper application of the EU Free Flow of Non-Personal Data Regulation / Article 6 "Porting of Data".

([53]) See footnote 4.

([54]) See https://data.consilium.europa.eu/doc/document/ST-7413-2023-INIT/en/pdf

(237) Second, positive externalities are not appropriated sufficiently, in particular in an open-source environment. Individual open-source projects provide benefits to third parties and society that are not fully captured by the undertakings, as open-source code is available to anyone. As a result, the latter's private rate of return may not be sufficiently attractive for each project to be funded fully privately, even though the overall benefits of that project would justify the investment from a societal perspective. This leads to underinvestment in innovative technologies along the cloud edge continuum, from a societal perspective. This has resulted in the prevalence of proprietary solutions and thus a lack of open-source solutions generating the described positive externalities for society as a whole.

(238) Third, negative environmental externalities remain unaddressed. Negative externalities occur when a company does not bear the full cost of the harm they impose on society. In the data processing market, such negative environmental externalities that are relevant for the IPCEI CIS, are mainly due to the carbon footprint associated with the usage of cloud resources and the energy consumed to transport, store, and handle data in data centres including energy costs related to cooling. As the Member States submit, the current regulatory environment does not fully internalise the costs of carbon production related to energy consumption.

(239) The Commission concludes that IPCEI CIS aims to address these three important market failures as follows. First, the integrated, coordinated and simultaneous nature of the individual projects in IPCEI CIS is expected to address coordination failures in the development of a common interoperable and open cloud-to-edge environment. In particular, in an open-source system there are strong network effects due to mutually reinforcing entrepreneurial activity within a cluster of companies. The support under IPCEI CIS helps align the incentives of multiple actors along the cloud edge continuum, thereby enabling upfront simultaneous investments. Therefore, the support on the cloud edge services is likely to help generate a whole ecosystem around it. IPCEI CIS will develop a reference architecture, which allows for portability of data across all capabilities and deliverable tasks as a collaborative effort shared among beneficiaries.

(240) Second, the individual projects in IPCEI CIS are expected to address positive externalities of innovation efforts, the benefits of which are not fully internalised by the beneficiaries and which absent the aid, would result in a societal loss due to the undertakings not having a sufficient financial incentive to invest in the innovation. Innovation effects will likely not to be fully internalised by the beneficiaries, even more so in an open-source system, i.e. undertakings share the stock of knowledge with other undertakings without necessarily being directly compensated for it. Successful innovations will generate ideas also for other players who can in turn build on the successful innovation of others. For instance, investments in cybersecurity of one company generate positive externalities for other companies using the same open-source system as individual contributions to cybersecurity benefit the system as a whole. In contrast, in proprietary systems, individual investments in cybersecurity are mainly limited to the proprietary system itself. Therefore, the financial support as part of IPCEI CIS will help to unlock the positive external effects from an interoperable open-source standard.

(241) Third, the individual projects in IPCEI CIS will contribute to addressing negative externalities, by developing highly innovative solutions and green technologies along the cloud edge continuum towards less energy-consuming and less polluting solutions. In this context, one of the objectives of IPCEI CIS is to promote the development and/or adoption of "cleaner" technologies and processes. Software developed under IPCEI CIS supports the management of services on top of highly secure and climate-neutral edge nodes and offers developments towards more energy efficient data centres, thus helping to limit negative environmental external effects due to an increase in energy consumption of the data processing industry in the future.

(242) The Commission has assessed each project on an individual basis with respect to the identified important market failures. The large majority of projects address at least coordination failures due to the coordinated and simultaneous nature of IPCEI CIS or positive externalities due to their open-source nature. In addition, a number of projects also address negative environmental externalities.

(243) Based on the above, the Commission concludes that the eligibility condition of point 15 of the IPCEI Communication is fulfilled.

3.3.2.2.3. Member States involved

(244) Point 16 of the IPCEI Communication requires that (i) at least four Member States must ordinarily be involved in an IPCEI and (ii) its benefits must not be confined to the financing Member States but extend to a wider part of the Union, whereas those benefits must be clearly defined in a concrete and identifiable manner. The notified IPCEI CIS involves 7 Member States, i.e.: France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain, and, as shown in recitals (246) to (261), its benefits are widely spread and defined in a concrete and identifiable manner. The Commission therefore concludes that the eligibility condition of point 16 of the IPCEI Communication is fulfilled.

3.3.2.2.4. Open procedure for Member States

(245) On 15 October 2020, all 27 Member States signed a joint Declaration on "Building the next generation cloud for businesses and the public sector in the EU" in which they committed to work together towards a European cloud federation initiative. In this vein, in December 2020, France, Germany, Italy and Spain informed all Member States of the initiative to set up an IPCEI on cloud infrastructure and services and invited them, as well as any interested European stakeholders, to participate in the process (see recital (1)). Therefore, in line with point 17 of the IPCEI Communication, all Member States were informed and had the opportunity to participate in this initiative. The eligibility condition of ensuring a genuine opportunity for all interested Member States to participate in IPCEI CIS is thus fulfilled.

3.3.2.2.5. Positive spillover effects

(246) Point 18 of the IPCEI Communication requires that an IPCEI must benefit the Union economy or society via positive spillover effects. In particular, the benefits of the project must not be limited to the undertakings or to the sector concerned but must be of wider relevance and application to the economy or society in the Union through positive spillover effects (such as having systemic effects on

multiple levels of the value chain, or up- or downstream markets, or having alternative uses in other sectors or modal shift) which are clearly defined in a concrete and identifiable manner.

(247) The IPCEI Communication requires that spillover effects go beyond the Member States involved in the IPCEI ("economy or society in the Union"); beyond the aid beneficiaries ("not be limited to the undertakings") and beyond the sector(s) in which the aid beneficiaries are active ("[…] or to the sector concerned").

(248) With the commitments for spillover effects submitted for each individual project, the Member States propose different general and IPCEI CIS-specific spillover activities in order to ensure the dissemination of knowledge, know-how, project results and technologies developed beyond the direct participants, the participating Member States and the IPCEI CIS ecosystem. As described in Section 2.6, the aid beneficiaries commit to a variety of spillover activities, ranging from dissemination of knowledge, commitments with regards to intellectual property, additional and proactive efforts in open-source communities, providing access to third parties to infrastructure elements, and transposition of the projects' results in other economic sectors. The spillover commitments proposed by the direct participants will enable the exchange of information and know-how, while also enhancing innovative solutions, cooperations, and further development of the technologies concerned.

(249) As regards spillover effects for non-IP protected results of R&D&I and FID activities, the Member States have provided an extensive list of activities (described in section 2.6.1) illustrating that the results of IPCEI CIS are not limited to the participating undertakings and the Member States concerned, but will be disseminated to the scientific and professional communities and be of wider relevance and application to different economic sectors. For example, the Commission recognises that involvement in conferences and events as speakers, contributors, or participants will contribute to the dissemination of the knowledge, skills and technologies obtained through IPCEI CIS, as these regular events attract specialised target groups (i.e. undertakings, ROs, universities) and provide a forum for the exchange of information, ideas, results, technologies and innovative developments (see section 2.6.1.2).

(250) The Commission also notes the significant effort undertaken by the direct participants to spread and share knowledge and results through publications in peer-reviewed journals (see section 2.6.1.4) and in increasing links with the scientific community, including through collaborations and sponsorship of PhD and MSc degrees and university chairs related to the technologies developed under IPCEI CIS (see Section 2.6.1.3). This provides an opportunity to transfer the knowledge gained from IPCEI CIS and the individual projects' results to future professionals and the future workforce, who could thus acquire skills and knowledge that will be needed in the future. This is, furthermore, corroborated by the commitments undertaken by the participating undertakings to provide training activities in collaboration with ROs and universities, targeting professionals and researchers (see recital (163)).

(251) As regards spillover effects for IP-protected results of R&D&I (see section 2.6.2), the Commission considers that the Member States have adequately described the commitments undertaken by the participating undertakings to spread those results to all interested parties and across economic sectors beyond the Member States involved, by committing to non-exclusive licensing of these IP-protected results

on FRAND conditions to any interested party. Thus, the IP-protected results will not only benefit the participating undertakings but will also be widely and non-discriminatorily available to all interested parties beyond the undertakings generating those results during IPCEI CIS.

(252) In addition to the above, IPCEI CIS entails some spillover commitments that are specific to it. The first group of positive spillover commitments particular to this IPCEI is due to the fact that most of the direct participants in IPCEI CIS are engaged in delivering their projects' results as open-source software. These aid beneficiaries commit to specific spillover effects associated with this activity (see section 2.6.3). While the delivery of the projects' results as open-source (as opposed to proprietary) software is in itself beneficial for the sector ([55]), the direct participants also commit to undertake significant extra efforts that go beyond the intrinsic benefits of releasing open-source software and beyond the direct participants' usual practices and business models, as described below, in order to maximise the open-source effects.

(253) These commitments for extra efforts encompass, for example: the granting of permissive, non-restrictive open-source software licenses; adhering to a common and open-source governance framework during and after IPCEI CIS; setting up an open-source community (comprised of direct participants and indirect partners to IPCEI CIS, as well as any interested third party); actively maintaining and growing the communities (including also in instances where the direct participants will contribute to already existing communities) after the initial software has already been developed. Furthermore, other commitments entail continuously maintaining the developed open-source software, providing coherent documentation (e.g., manuals) of the developed open-source solutions, devoting additional human resources to the community building and maintaining, actively engaging further contributors and organising hackathons, where any interested third party gets access to new functionalities to test and validate their know-how and to develop further innovative solutions.

(254) As part of the spillovers associated with the extra efforts in open-source software the direct participants also commit to actively promote and facilitate the use of the software that has been developed, by providing – among other things – targeted trainings, tutorials, support services (starter kits, technical support, ancillary services, manuals and other documentation) and events (e.g. seminars, hackathons).

(255) In sum, through these extra efforts the possibilities offered by the release of open-source software will become well-known and numerous players will be able to benefit not simply from the new software and technologies, but also to develop and extend them further, thus resulting in additional advancements and benefits in the field.

(256) These spillover activities associated with the open-source software have a wide and open target group that includes the open-source communities, the undertakings' competitors and the customers/end users of the open-source software. Thus, the benefits of the IPCEI CIS open-source projects' outputs will

([55]) As explained in footnote 12, open-source software is publicly available and its source code can be inspected, modified and enhanced by any user.

be spread to all interested parties, including other market players, as well as in other Member States, in order to boost both the adoption of the IPCEI CIS results and further innovations.

(257) The second group of positive spillover effects that is particular to IPCEI CIS concerns the granting of access to the infrastructure elements or laboratories that are supported as part of the R&D&I and/or FID phases of the projects of several direct participants in order to develop, test or upscale the software concerned. The direct participants concerned have committed, as a spillover effect, to grant access to at least 20% of the annual capacity of these infrastructure elements for free to any interested third party (see Section 2.6.4). Moreover, training and support services offered by the direct participants concerned aim at facilitating the efficient sharing of such infrastructure elements. Furthermore, some direct participants commit to providing a digital, live demo of their project results and allowing other users to experiment on those, effectively guaranteeing an equivalent result. Through this possibility, the interested user can obtain knowledge and advance their own research remotely. Through these spillover activities, interested third parties, including competitors, will obtain access to the relevant infrastructure elements and will have the opportunity to develop and test their own software and technologies in an appropriate environment. In turn, this will allow and foster further research and development, by other market players and in other Member States.

(258) The third group of positive spillover effects particular to IPCEI CIS stems from the FID phase of the projects, during which use cases are performed. The direct participants concerned committed to expand the (specific sector-related) use cases that form part of their projects' FID activities to additional sectors of the economy (see Section 2.6.5), to produce self-standing technical material, business case studies and to organise trainings. In that way, undertakings from those additional sectors will be able to acquire know-how, and best practices, will be able to apply the developed technologies and to adapt the use cases into solutions for other sectors and thus make use of the knowledge and skills generated during the individual projects within IPCEI CIS. Thus, the beneficial results stemming from the integrated project will be made directly applicable to additional economic sectors and will be used by other market players, including in upstream/downstream markets.

(259) Based on the description of the positive spillover effects generated by IPCEI CIS as presented in section 2.6 and analysed in the preceding recitals, the Commission considers that the benefits of this IPCEI are clearly defined in a concrete and identifiable manner. Moreover, the Member States have adequately shown how IPCEI CIS benefits interested parties beyond those directly involved in it and beyond the Member States and economic sectors concerned. In addition, the correct implementation of the committed dissemination activities and spillovers of the participating undertakings will be monitored (see recitals (67) and (69)) in compliance with the point 52 of the IPCEI Communication and the national funding agreements.

(260) Furthermore, the Commission takes note of the statement of the Member States of the existence of collaborations in IPCEI CIS, which will create an ecosystem of direct participants with the indirect partners, thus expanding the positive spillover effects through this IPCEI to these indirect partners (see section 2.6.6).

(261) In view of the above the Commission considers that the eligibility condition of providing positive and effective spillovers is satisfied, in accordance with point 18 of the IPCEI Communication.

3.3.2.2.6. Co-financing by the aid beneficiaries

(262) As required by point 19 of the IPCEI Communication, the project must involve important co-financing by the beneficiaries. The total financing needs for the implementation of the IPCEI CIS beneficiaries' projects amount to approximately EUR 2.6 billion in total. The Commission assessed the co-financing and found that the beneficiaries will together co-finance more than EUR 1.3 billion in total. Therefore, the eligibility condition of point 19 of the IPCEI Communication is fulfilled.

3.3.2.2.7. Principle of "do no significant harm"

(263) Point 20 of the IPCEI Communication requires Member States to provide evidence as to whether the project complies with the principle of "do no significant harm" within the meaning of Article 17 of Regulation (EU) 2020/852 (the "Taxonomy Regulation"), or other comparable methodologies ([56]).

(264) Article 17 of the Taxonomy Regulation defines what constitutes "significant harm" for the six environmental objectives covered by this Regulation. It requires an assessment, taking into account the life cycle of the products and services provided by an economic activity including evidence from existing life cycle assessments, scrutinising whether:

(a) an activity is considered to do significant harm to climate change mitigation if it leads to significant greenhouse gas (GHG) emissions;

(b) an activity is considered to do significant harm to climate change adaptation if it leads to an increased adverse impact of the current climate and the expected future climate, on the activity itself or on people, nature or assets;

(c) an activity is considered to do significant harm to the sustainable use and protection of water and marine resources if it is detrimental to the good status or the good ecological potential of bodies of water, including surface water and groundwater, or to the good environmental status of marine waters;

(d) an activity is considered to do significant harm to the circular economy, including waste prevention and recycling, if it leads to significant inefficiencies in the use of materials or in the direct or indirect use of natural resources, or if it significantly increases the generation, incineration or disposal of waste, or if the long-term disposal of waste may cause significant and long-term harm to the environment;

(e) an activity is considered to do significant harm to pollution prevention and control if it leads to a significant increase in emissions of pollutants into

([56]) Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (OJ L 198, 22.6.2020, p. 13).

air, water or land, as compared with the situation before the activity started; and

(f) an activity is considered to do significant harm to the protection and restoration of biodiversity and ecosystems if it is significantly detrimental to the good condition and resilience of ecosystems, or detrimental to the conservation status of habitats and species, including those of Union interest.

(265) In order to assess compliance with point 20 of the IPCEI Communication, the Commission required Member States to provide evidence that demonstrates that the individual projects comply with the above-mentioned six environmental objectives of the Taxonomy Regulation, by reference in particular to the screening criteria developed in Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives (the "Delegated Regulation") ([57]).

(266) The Member States have submitted information of the environmental impact of all of the individual projects against the six environmental objectives set out in Article 9 of the Taxonomy Regulation indicating the following.

(267) The Member States have demonstrated that several individual projects include concrete activities to reduce energy consumption, e.g., beyond the state-of-the-art design of electric immersion techniques, innovative technologies for cooling systems, optimal utilisation of energy efficient data storage and the decrease of data transfers via edge processing. In addition, the Member States provided information that IPCEI CIS envisages environmentally friendly, resource-efficient technologies such as intelligent workload management for the shaping of a climate-efficient data processing market by creating the next generation of cloud and edge infrastructure and services. Furthermore, the Member States submitted that IPCEI CIS will also allow to reduce data flow amounts between edge and cloud data facilities. Thus, in turn, this will allow to reduce energy consumption stemming from data communication activities. The Member States also submitted that IPCEI CIS will open up sustainability potential for other sectors that will mitigate climate change through smart information and communication technology (ICT) solutions, for instance by offering concrete information on the energy consumption of software for industry and for other sectors. Concerning climate change mitigation, the Commission concludes that the Member States have shown that advancements related to that criterion are expected to be achieved by the reduction of energy consumption, as well as by an increase in energy efficiency of novel advanced data processing technologies and by applications developed under IPCEI CIS, which, in turn, are expected to lead to a reduction of emissions.

(268) The Member States have shown that the reduction of consumption and increase in energy efficiency is a key research area for several individual projects selected for

([57]) OJ L 442, 9.12.2021.

IPCEI CIS, e.g. optimisation of energy-efficient processing of data in real time, while promoting scientific exchange for the development of new green technologies for sustainable data processing activities. Moreover, the Member States have indicated that blueprints, i.e. design concepts for the necessary sustainable data processing infrastructure, will be provided to design future advanced data processing equipment, facilities and services that will guarantee sustainability in real time. Concerning climate change adaptation, the Commission considers that, based on the provided information, no negative effects are foreseeable.

(269) Concerning the sustainable use and protection of water and marine resources, those individual projects that involve relevant activities using such resources are not expected to have a significant negative effect on the sustainable use and protection of water and marine resources. Furthermore, the Member States submitted information on the sustainable use of water across the operations of climate-efficient data processing facilities envisaged, especially to reduce the water consumption. In this regard, the Member States explained that some projects will develop specific processes that will contribute to promoting advanced cooling techniques going beyond the state-of-the-art, for example new liquid two-phase immersion cooling technology; the use of natural CO_2 refrigerants, hydrogen or extended free cooling, while also significantly improving the efficiency of existing cooling systems such as direct hot water cooling. To this end, the Commission concludes that the individual projects are not expected to negatively affect the sustainable use and protection of water and marine resources.

(270) The Member States have also shown that the individual projects under IPCEI CIS will contribute to the circular economy, including waste management, thereby fulfilling the required standards of preventing significant harm, especially by observing all requirements on waste electrical and electronic equipment and the restrictions on the use of hazardous substances in electrical and electronic equipment by fully adhering to current EU requirements. In addition, several undertakings will use existing hardware and infrastructure to reduce the consumption of materials. To this end, the Commission considers that IPCEI CIS will contribute to the circular economy, as it for instance involves activities aiming at longer life cycles and/or a second life of hardware and infrastructure components through the development of reuse and up-cycling models.

(271) Further, several direct participants have outlined that there is no connection between their activities and the pollution prevention and control of air, water and land, e.g., by using electricity from renewable sources. Furthermore, in some cases, the direct participants plan to carry out R&D&I on the heat transfer systems, heat integration and data centre operating temperatures towards less energy-consuming and less polluting solutions, by reducing the load on heating, ventilation and air conditioning technology, while also eliminating hazardous substances in electrical and electronic equipment. Therefore, the Commission concludes that it is unlikely that the activities carried out under this IPCEI will lead to a significant increase in emissions of pollutants into air, water or land.

(272) Finally, the protection and restoration of biodiversity and ecosystems play a minor role for the individual projects in IPCEI CIS. All individual projects are expected to have no or just an insignificant negative impact on the protection and restoration of biodiversity and ecosystems, especially as most participating undertakings will utilise already existing sites and/or working on software

solutions. The Member States confirm that new data processing facilities (e.g. edges) for IPCEI CIS will not be constructed in or near biodiversity-sensitive areas. As a result, the Commission considers that this IPCEI will not have a significant negative impact on the protection and restoration of biodiversity and ecosystems.

(273) The Member States confirm that compliance with the "do no significant harm" principle will be part of the regular monitoring processes of the integrated project.

(274) In view of the above, the Commission considers that this eligibility condition is satisfied, in accordance with point 20 of the IPCEI Communication.

Conclusion

(275) Based on all of the above considerations, the Commission considers that the general cumulative criteria for eligibility set out in Section 3.2.1 of the IPCEI Communication for aid to be compatible under Article 107(3)(b) TFEU are met.

(b) General positive indicators (section 3.2.2 of the IPCEI Communication)

3.3.2.2.8. Involvement of the Commission in the design

(276) The Commission facilitated the emergence of IPCEI CIS and helped enhance coordination between Member States in the project by having, during the period preceding the pre-notifications, participated in and contributed to several technical meetings with open invitations for all Member States interested in participating in IPCEI CIS. Point 21(a) of the IPCEI Communication is therefore fulfilled.

3.3.2.2.9. Involvement of the Commission in the governance

(277) As described in detail above under section 2.4, the governance structure of IPCEI CIS involves the Commission through its participation in the SB. Point 21(c) of the IPCEI Communication is therefore fulfilled.

3.3.2.2.10. Important collaborative interactions

(278) The Member States provided detailed information (see section 2.5.6) describing how each individual project creates important collaborative interactions in terms of the number of partners, involvement of undertakings participating in the same and different WS and the involvement of undertakings of different sizes.

(279) The Member States have provided information on multiple cross-border collaborations between the direct participants within each and across the different WS, as illustrated in Figure 8 and further elaborated in section 2.5.6 (collaborations within IPCEI CIS).

Figure 8 - Overview of cross-border collaborations between direct participants

(280) These collaborations are in line with point 21(d) of the IPCEI Communication.

3.3.2.2.11. Co-financing from a Union fund with direct, indirect or shared management

(281) At the time of the decision, four Member States ([58]) have indicated that they will finance their projects through the RRF. The inclusion of co-funding or co-financing of individual projects within IPCEI CIS is consistent with point 21(e) of the IPCEI Communication.

3.3.2.2.12. Significant strategic dependency

(282) Apart from the market failures described under Section 3.3.2.2.2 (Important market failures), the individual projects of IPCEI CIS will contribute to the establishment of a European cloud edge continuum ecosystem, thus providing for the possibility to develop and provide such technologies. As described in recital (232), the market is currently dominated by the so-called (non-EU based) hyperscalers. Therefore, the enhanced presence of European players as well as the provision of an end-to-end ecosystem, allowing for new and innovative data processing capabilities, will help reduce dependencies on third-country providers and support the growth of the cloud, edge and cloud to edge market segments in the Union.

([58]) The Member States that indicated their intention to use funds from the RRF are: Germany, Italy, Poland and Spain.

(283) Thus, IPCEI CIS supports the Union's policy to decrease a clearly identified, significant and strategic dependency on non-European cloud technologies (see recital (282)). This is consistent with point 21(g) of the IPCEI Communication.

3.3.2.2.13. Conclusion on general cumulative criteria and general positive indicators

(284) In view of all of the foregoing, the Commission considers that all general cumulative criteria laid down in Section 3.2.1 of the IPCEI Communication are met. Also, five out of seven general positive indicators, as laid down in Section 3.2.2 of the IPCEI Communication are met.

(c) Specific criteria (Section 3.2.3 of the IPCEI Communication)

3.3.2.2.14. Specific criteria for projects involving R&D&I and FID activities

(285) All individual projects within the four WS comprise either R&D&I or both R&D&I and FID activities.

(286) Point 22 of the IPCEI Communication provides that R&D&I projects must be of a major innovative nature or constitute an important added value in terms of R&D&I in light of the state-of-the-art in the sector concerned.

(287) According to point 23 of the IPCEI Communication, projects comprising of FID must allow for the development of a new product or service with high research and innovation content or the deployment of a fundamentally innovative production process. Regular upgrades without an innovative dimension of existing facilities and the development of newer versions of existing products do not qualify as FID. Further, point 24 of the IPCEI Communication defines FID as the upscaling of pilot facilities, demonstration plants or of the first-in-kind equipment and facilities covering the steps subsequent to the pilot line including the testing phase and bringing batch production to scale, but not as mass production or commercial activities. FID activities can be financed with State aid as long as the first industrial deployment follows on from an R&D&I activity and itself contains an important R&D&I component which constitutes an integral and necessary element for the successful implementation of the project.

(288) The Member States showed that each project within the different WS has a well-defined and documented research programme to accomplish its objectives and deliverables regarding the innovations brought forward. The Commission conducted a technical assessment of each individual project to determine whether the projects that contain R&D&I and FID activities comply with the innovativeness requirements as laid out in the IPCEI Communication. Individual projects were deemed to have shown such major innovative nature, if they could demonstrate important added value in terms of R&D&I beyond the global state-of-the-art in at least one of the following advances, specific for the scope of IPCEI CIS, that are relevant for both R&D&I and FID:

(a) Technical performance and novel capabilities beyond that of the current global state-of-the-art technology;

(b) first industrial deployment of a technology at a scale that clearly goes well beyond the current global state-of-the-art; and

(c) innovative applications or innovativeness of overall processes/approaches beyond the global state-of-the-art.

(289) In particular, the innovative nature of each individual project carrying out R&D&I and FID activities was analysed taking into account the following specific principles and parameters.

(290) For R&D&I:

(a) state-of-the-art: the Commission has compared outcomes and objectives of each participating undertaking's project against the global state-of-the-art;

(b) major innovativeness: as regards the technical assessment of the major innovative nature of the different projects, the Commission examined whether each individual project set specific targets for achieving the innovativeness required for the R&D&I activities proposed; whether those activities and targets go beyond the global state-of-the-art; the specific innovations beyond the global state-of-the-art brought forward; and the benefits and expected results stemming from these innovations; and

(c) technical developments: the participating undertakings were asked to provide a clear description of the technical developments needed to reach their important targets for innovativeness. The Commission assessed in this context, both at project level and at the level of the work package of which that project forms part:

- The completeness and accuracy of the relevant global state-of-the-art analysis;

- the adequate identification of global state-of-the-art shortcomings and gaps, offering solid evidence of surpass of the global state-of-the-art and of the importance and added value in terms of R&D&I of the project;

- the project outcomes' relevance and appropriateness of the objectives, the specific, measurable, achievable, relevant and time-bound indicators and the addressed technical challenges to accomplish the project innovations (see recital (296)).

(291) For FID:

(a) the Member States described the testing, R&D&I validation, and upscaling processes implemented by each individual project during the FID and explained how they differed from mass production and normal commercial activities;

(b) the Commission examined whether the FID contains important R&D&I activities in relation to the applicability of projects' results and outcomes to concrete use cases, for example by means of maturation, verification and optimisation of innovative solutions developed in the R&D&I phase, the implementation and integration of technological innovations in specific use cases of industrial sectors and the scaling up of different technologies from pilot to production-readiness stage;

(c) furthermore, for participating undertakings contemplating several integrations and use cases as part of FID, the Commission assessed the strict necessity and complementarity in terms of the research performed within FID among these use cases in order to reach the end of FID;

(d) the Commission further assessed the duration of the FID of each individual project, and whether each participating undertaking provided meaningful KPIs and evidence of the FID duration, notably the criteria determining its starting point (i.e., R&D&I project results) and end period (i.e., at which point the technology being developed and its associated outcomes achieve a production-readiness stage) and the scale of the FID to mass production (e.g., whether the FID corresponds to early demonstration and validation of project outputs and offer clear distinction to production ready solutions).

(292) Based on the information provided by the Member States and following an assessment against the relevant factors listed above, the Commission considers that the R&D&I and FID activities carried out in all of the four WS of IPCEI CIS aim to advance the relevant technology substantially beyond the current global state-of-the-art. The main general innovative solutions and key expected results that the Commission identified as part of the individual assessment of projects are described in the following recitals (295) and (296).

(293) The Member States have demonstrated the innovativeness of all the individual projects within the four WS of IPCEI CIS, including both R&D&I and FID activities, in all areas of the cloud and edge computing technologies that are specifically targeted by IPCEI CIS.

(294) As IPCEI CIS is an integrated project comprising of R&D&I and FID activities, point 25 of the IPCEI Communication is not relevant for the State aid assessment. Notwithstanding this, the Member States have ensured that any infrastructure elements included in the individual projects are strictly necessary for and thus limited to the purposes of R&D&I and FID activities. Moreover, as indicated in recital (257) and section 2.6.4., participating undertakings receiving support for infrastructure elements have committed to provide access to any interested third party to the supported infrastructure elements, thereby providing for a specific spillover effect beyond the IPCEI CIS ecosystem.

Major innovative nature and expected results

(295) The Commission considers that the Member States have demonstrated the innovativeness of IPCEI CIS including both R&D&I and FID activities, in all areas covered by the integrated project.

(296) The key expected results of R&D&I and FID activities in terms of major innovative solutions and the corresponding contributions of the participating undertakings in the individual WS of IPCEI CIS are the following:

Workstream 1

Cloud-Edge Continuum Infrastructure

Highlighted Innovations per key research area	Participating Undertakings
Interconnection and federation enablement: Development of technological, operational, and organisational solutions for the integration of new and existing European data processing networks (mobile and fixed) and facilities at the edge. The solutions will focus on the integration of novel edge data processing locations (near edge, far edge / on-premises) across providers and across borders.	DTAG, Telefónica
Multi-provider QoS guarantees and workload placement: Development of technological, operational, and organisational solutions to augment existing technologies with new capabilities regarding guaranteed QoS between across different diverse and disperse providers and countries, e.g., guaranteed maximal latencies and minimal bandwidths. These incorporate the application of QoS requirements and guarantees to workload placement strategies, along with the integration of high-performance computing approaches (HPC / bare metal).	DTAG, Telefónica
Open reference designs and configurations: The development of blueprints and implementations that offer data processing service providers open reference designs and settings for data centres, decentralised edge facilities, and related resources. These will be specially designed to meet the needs of telco cloud and their integration requirements with the Cloud Edge Continuum. The goal of these open and standard settings is to guarantee a similar service experience and a common comprehension of the attributes outlined in service level agreements (SLAs).	Telefónica
Cybersecurity: Development of technological, operational, and organisational solutions for a federated cybersecurity on the level of data processing facilities including the development of federated cybersecurity solutions utilising advanced methods like homomorphic encryption and quantum key distribution as well as adhering to security concepts like zero-trust.	DTAG
Sustainability: Development of technological, operational, and organisational solutions to increase the energy efficiency of different types of data processing facilities, e.g.., near edge and far edge / on-premises facilities including the use of local renewable energy sources, energy-aware scheduling of data processing workloads, efficient cooling solutions and waste heat reuse.	DTAG, Telefónica

Availability / Accessibility: Development of open-source models, solutions and configurations along with their contribution to reference open-source communities, such as the Linux Foundation, to push the boundaries of technology and maximise the availability and impact of solutions for providers of data processing services in the Multi Provider Cloud Edge Continuum.	DTAG, Telefónica

Table 14 - Highlighted innovations within WS 1

Workstream 2 **Cloud-Edge Capabilities**	
Highlighted Innovations per key research area	**Participating Undertakings**
Life Cycle Management: Development of new open methods and technologies for managing the life cycle of federated resources, services and applications across provider boundaries, across the continuum and for telco edge solutions. This includes, e.g., resource discovery, resource allocation and management, scheduling, automatic and optimised deployment of distributed applications, as well as migration, porting and updates of distributed applications. It also entails handling a variety of resources, including those connected to processing, data, and network. The results will be part of a common open reference architecture for the Multi Provider Cloud Edge Continuum.	Orange, SAP, Open Nebula, Leaseweb, Arsys
Data and Network Management: Development of open-source components with a particular focus on resource efficiency and optimal distribution of data, its monitoring, as well as deployment concepts. This also includes software-based network resource management and operation. In addition, it includes development of new methods and technologies for data exchange in a Multi Provider Cloud Edge Continuum in the form of composable data transfer services. Further, development of new methods and technologies for cryptographically secured data processing and trustworthy backup of distributed data.	Orange, TIM, Open Nebula, Reply, Atende
Workload Management: Development of new, open methods and technologies for the management of workloads including orchestration and scheduling among other aspects, being distributed on various types of data processing locations (IoT, on premises, far edge, near edge, cloud) across provider boundaries and along the Continuum. The results will be part of a common open reference architecture for the Multi Provider Cloud Edge Continuum.	Atende, Atos, Arsys, Orange, Open Nebula, SAP, Oktawave, Reply

Cybersecurity: Development of a cross-provider cybersecurity methods and processes at technological, operational, and organisational levels. The solutions contemplate diverse data protection mechanisms as well as identity management, key management, management of access rights, privacy as well as payment solutions. The results will be part of a common open reference architecture for the Multi Provider Cloud Edge Continuum.	Atos, Orange, SAP, Reply, TIM, Oktawave, Open Nebula
Sustainability: Development of new, open methods and technologies for carbon footprint management and energy optimisation. The solutions will be based on the monitoring of interoperable telco/edge workloads, AI-based optimisation strategies, as well as advanced analysis of energy usage utilising modelling and optimisation across the Multi Provider Cloud Edge Continuum.	Atos, Orange, SAP, Open Nebula, Arsys
Availability / Accessibility: Development of a common open reference architecture for the Multi Provider Cloud Edge Continuum including new methods and technologies for business processes across provider boundaries with solutions for, e.g., compliant modes of operation and communication among diverse providers offerings, new collaborative business models, or clarification of legal aspects and responsibilities within joint operations.	SAP, Arsys, Reply, Leaseweb

Table 15 - Highlighted innovations within WS 2

Workstream 3 - Advanced smart data processing tools and services	
Highlighted Innovations per key research area	**Participating Undertakings**

Data Handling: Development of data mesh concepts to support all types of data (streaming, event, real time, time series, and others), and the management of their exchanges across provider boundaries. Development of dynamic data caches to optimise end-to-end data access while reducing the overall traffic and processing. Development of new open methods to improve the discoverability and interoperability of data and services at scale throughout the Multi Provider Cloud Edge Continuum.	4iG, E-Group, CloudFerro
AI Capabilities: Development of end-to-end, interoperable data and AI management frameworks that address the current deficiencies of scaling AI solutions across provider boundaries by, inter alia, decoupling data from processing and insight generation, use of advanced processing technologies as well as developing new methods and technologies for distributed learning mechanisms. Development of tools such as a low code / no code platform for the development of generative AI models and solutions.	E-Group, Tiscali
Advanced Service Orchestration: Development of advanced services that allow for a variety of container management systems to seamlessly and securely share and orchestrate resources and services, so that tasks can be run on any appropriate available data processing resource in an optimiSed way within the Multi Provider Cloud Edge Continuum.	Tiscali, CloudFerro

Table 16 - Highlighted innovations within WS 3

Workstream 4 – Advanced Applications	
Highlighted Innovations per key research area	**Participating Undertakings**

IT/OT Convergence: Development of new methods and technologies to close the gap between the cloud edge IT domain and the industrial OT domain regarding the integration and operation of complex industrial applications. Edge systems will be enhanced to meet the diverse industrial-grade requirements like hard real-time, uninterrupted stability, certifiable safety, guaranteed longevity, or brownfield connectivity. Further results include a reduction of adoption barriers for the IT-non-experts from the OT domain through the use of no-code/low code approaches, and the seamless reusability of components.	Siemens, Fincantieri
Sector - specific digital twins and integration of AI into operational processes: Development of new methods and technologies to extend the digital twin paradigm to become a key mechanism to achieve transferability of sector-specific (e.g. health, energy, cultural heritage, urban transformation) data processing solutions, as well as to incorporate machine learning and artificial intelligence into industrial processes to address challenges particular to each industry. This extension entails capabilities for distributed storage, reuse of sector-agnostic processing components, standard-based interoperability mechanisms, integration of machine learning, IoT data processing, as well as enhanced cybersecurity.	Fincantieri, Engineering
Data ownership and data security: Development of new methods and technologies to unlock data silos by ensuring security, interoperability, data governance, consent management, and portability of data across provider boundaries. Key aspects include the fine-grained control of data usage by the respective data owners, as well as cybersecurity measures that protect against data theft and data manipulation.	Engineering

Table 17 - Highlighted innovations within WS 4

3.3.2.3. Importance of IPCEI CIS

(297) According to section 3.3 of the IPCEI Communication (point 26), in order to qualify as an IPCEI, a project must be important quantitatively or qualitatively or imply a very considerable level of technological or financial risk, or both. To determine the importance of a project, the Commission will take into account the criteria set out in section 3.2 of the IPCEI Communication. As demonstrated below, IPCEI CIS is significantly large in size and scope and implies a very considerable level of technological and financial risk.

(298) The Commission considers IPCEI CIS to be an important project meeting the quantitative and qualitative requirements set out in section 3.3 of the IPCEI Communication, based on the following:

- IPCEI CIS represents an important contribution to Union's objectives (see recitals (222) to (230));

- IPCEI CIS is designed to overcome important market or systemic failures (see recitals (231) to (243));

- 7 Member States and 19 undertakings participate directly in IPCEI CIS (see recitals (4) and (40)) while 90 indirect partners are further involved (see recital (61) and Annex II));

- IPCEI CIS' total State aid amounts to EUR 1.2 billion in nominal terms (see Table 12 under recital (186));

- all Member States were given the opportunity to participate in IPCEI CIS (see recital (245));

- IPCEI CIS generates positive spillover effects (see recitals (246) to (261));

- IPCEI CIS involves important co-financing by the aid beneficiaries (see recital (262));

- IPCEI CIS complies with the principle of 'do no significant harm' (see recitals (263) to (275));

- The Commission was involved in the design of IPCEI CIS (see recital (276));

- The governance of IPCEI CIS involves the Commission (see recital (277));

- IPCEI CIS involves important collaborative interactions (see recitals (278) to (280));

- IPCEI CIS involves co-funding or co-financing from a Union fund (see recital (281)); and

- IPCEI CIS addresses a significant strategic dependency (see recital (283)).

(299) In addition to these indicators, the Commission notes that the qualitative importance of IPCEI CIS consists also:

(a) At a macro level, in the overall result of this IPCEI, namely the establishment of the Multi Provider Cloud Edge Continuum. Such an end-to-end cloud system, covering and available to the entire European market is unprecedented and will provide European citizens and undertakings with new capabilities (e.g., interoperability, low latency).

(b) At a micro level, in the specific characteristics of the Multi Provider Cloud Edge Continuum, which are also unprecedented, will constitute significant technological innovations beyond the global state-of-the-art and will enable new capabilities both for providers and users:

- interoperability, which will allow to enable European cloud market limitations to be overcome;

- open-source software, which will allow not only accessibility, but also the basis for further development and thus the creation of additional products and services within the ecosystem of the Continuum;

- the basic software layer constituting a blueprint also for future cloud to edge technologies, with reinforced capabilities in data-security and sustainability.

(300) In addition, there is a considerable level of risk relating to the integration and coordination requirements at the level of the overall IPCEI CIS, as well as the technological, economic and financial risks for the individual projects within IPCEI CIS.

(301) As this IPCEI aims at the establishment of an ecosystem of a Multi Provider Cloud Edge Continuum, encompassing various components and technologies, there is a necessity for a particularly high level of integration among the individual projects and specific deliverables. This also entails risks; for instance, the integration of edge nodes and central data processing facilities is key to ensure ultra-low latency.

(302) In the same vein, the components of IPCEI CIS (WS, products, project deliverables, partners etc) are interdependent among each other. As such, there are significant coordination and organisation risks. It is likely that not all deliverables are developed at the designated time or bear the designated qualities, thus having an impact on the subsequent products and potentially on the final outcome of the Continuum. This applies to various interdependent relations:

(a) between different WSs: as they aim to build upon each other, failure to deliver results as and when needed may endanger the development of the subsequent WS;

(b) between different actors: for example, unsuccessful execution of other projects or of a collaboration with other direct participants may pose a risk on the development of the relevant product(s);

(c) between different stakeholders: for instance, the execution of specific use cases requires the cooperation and coordination with other actors (not participating in this IPCEI), such as local authorities, which will need to be engaged for example in smart city use cases;

(d) between different economy sectors: for instance, the execution of sector-specific use cases requires coordination between market players coming from different sectors of the economy, thus being acquainted with different methodologies or working processes; moreover, dependencies on other sectors reveals supply chain risks. For example, edge nodes will need to embed microelectronics components and, as such, they are exposed to the semiconductor supply chain risk.

(303) As regards technological risks, these include failure in performance and sustainability of the technologies developed. Such issues may lead to unforeseen additional work, thus resulting in increased costs or delays. In particular, technical failures in the R&D&I phase will necessarily cause delays or require adaptations in the FID phase. Apart from that, taking into account the high pace at which the IT sector progresses, there is a risk that the technologies developed in IPCEI CIS,

within a short period of time, become obsolete or incompatible with other products that are developed simultaneously and may acquire a strong position in the market, thus turning into (de facto) standards or widely accepted technologies. For instance, this may be the case in the field of data exchange or cybersecurity.

(304) The development of the Multi Provider Cloud Edge Continuum also faces financial and economic risks, considering the significant amounts of eligible costs and State aid involved in IPCEI CIS. The financial risk is proportionate to the high R&D&I content in the individual projects and the significant efforts to be undertaken by the participating undertakings to advance their individual projects. It also relates to the fact that IPCEI CIS establishes collaborations between actors of different size, structure and financial capacity.

(305) Moreover, IPCEI CIS takes place in a fast-paced and highly volatile sector. While it is generally known that the IT sector is growing, there is also a high level of uncertainty when it comes to successful products and services, features that achieve a wide acceptance in the market. In other words, the success of a product on the market is unpredictable. At the same time, the IT sector in general, as well as the cloud and edge sector more concretely, are capital and human resource intensive and highly dependent on R&D&I. This uncertainty may lead the participating undertakings limit the potential losses, as a consequence of those associated risks, for instance by postponing their R&D&I and FID efforts.

(306) All of the above-mentioned risks that the participating undertaking are confronted with during the implementation of their individual projects, demonstrate that IPCEI CIS as a whole can help the participating undertakings to overcome or at least minimise those risks and hence demonstrate the importance of the IPCEI. More concretely, the technical risks are minimised by the fact that the majority of individual projects are based on open-source software and will be openly accessible facilitates the identification, management and quick communication of potential issues to other sectors. Also, the validation of use cases in various sectors ensures the early involvement with the new products and services and aims to demonstrate the validity of the solutions, thus increasing the chances for early adopters and a wide network of final users. Consequently, the usage of the products concerned in the market is accelerated, thus minimising the economic or financial risks that potential delays could have created. Finally, financial or economic risks are mitigated through mobilising State aid in a synchronised manner for all participating undertakings, either directly thanks to the direct grants provided by the Member States, or indirectly, by easing the access to private co-financing.

3.3.2.4. Conclusion on the eligibility of IPCEI CIS

(307) In view of the above, the Commission considers that IPCEI CIS meets the eligibility criteria of the IPCEI Communication.

3.3.3. Compatibility criteria

(308) When assessing the compatibility with the internal market of aid to promote the execution of an IPCEI on the basis of Article 107(3)(b) TFEU, point 27 of the IPCEI Communication requires the Commission to take into account a number of criteria, as elaborated in the present section. Moreover, point 28 of the IPCEI Communication also requires the Commission to carry out a balancing test to

assess whether the expected positive effects of the aid outweigh the possible negative effects.

(309) The Commission must analyse the compatibility criteria at the level of aid beneficiaries and per individual project.

3.3.3.1. Necessity and proportionality of the aid

3.3.3.1.1. Necessity of the aid

(310) According to point 30 of the IPCEI Communication, the aid must not subsidise the costs of a project that an undertaking would anyhow incur and must not compensate for the normal business risk of an economic activity. Without the aid, the realisation of the project should be impossible, or it should be realised in a smaller size or scope or in a different manner that would significantly restrict its expected benefits. According to footnote 26 of the IPCEI Communication, the application for aid must precede the start of the works. According to point 31 of the IPCEI Communication, the Member State must provide the Commission with adequate information concerning the aided project, as well as a comprehensive description of the counterfactual scenario, which corresponds to the situation where no aid is awarded by any Member State.

(311) All direct participants submitted their applications for aid to the relevant Member States before the start of the works on their individual projects included in IPCEI CIS, therefore the formal incentive effect criterion, as required by the IPCEI Communication (footnote 26) has been met.

(312) The Member States have submitted information demonstrating that the aid has a substantive incentive effect for all aid beneficiaries, i.e., that the aid will induce the beneficiaries to change their behaviour by enabling them to engage in their individual projects in their full ambitious scope and in the time span as notified. This information is revealed in the counterfactual scenarios for each of the aid beneficiaries and by the insufficient rates of return, indicated by the negative net present value ("NPV") of the aided projects, in line with point 32 of the IPCEI Communication. Furthermore, the aid is kept to the minimum necessary to ensure the implementation of the projects in IPCEI CIS (see recitals (318) to (353)).

(313) The Member States submitted that, absent the public financing stemming from IPCEI CIS, each of the aid beneficiaries has demonstrated that it either: (i) would not undertake their individual projects and, for example, would continue technologically less advanced activities; (ii) alternatively, if the beneficiaries would develop alternative projects, they would not undertake them with sufficient speed, or they would carry out activities with a significantly lower level of ambition, for example from an innovative or environmental point of view.

(314) The Member States have underlined that, absent the aid, the development of an interoperable, accessible, secure and energy efficient Multi Provider Cloud Edge Continuum would not take place. The innovations in terms of both technical features (e.g. low latency, faster management of data and workloads, etc) and overarching capabilities (e.g. interoperability, accessibility to the users, extensive use of open-source software) would not be made available to the market, as each direct participant would have focused on its own, less ambitious programme.

(315) In this respect, the information provided by the Member States (e.g., reports, board presentations or minutes illustrating the choices, which the companies contemplated at the time of deciding on the IPCEI CIS project), shows that in the absence of aid, the participating undertakings would not undertake their individual projects and the participating undertakings had not considered alternative equivalently ambitious projects in their internal decision-making at the time of taking the decision to apply for the public support. Furthermore, an analysis of the factual and counterfactual scenarios in the context of the funding gap analysis (as discussed in recitals (331) to (344)) shows that the undertakings would not have had a financial incentive to implement their projects in the absence of aid.

(316) Regarding the assessment of the eligible costs, the Commission notes that the submitted costs do not include costs that an undertaking would have incurred in any event, such as costs linked to already existing software, on which regular upgrades and respective personnel costs would have been incurred even without IPCEI CIS. In view of the above, the Commission considers that the Member States have sufficiently demonstrated that the aid measures do not subsidise the costs of projects that the participating undertakings would have incurred in any event and do not compensate for their normal business risks.

(317) Considering the fact that the aid measures enable the participating undertakings to pursue ambitious projects, which would not have been pursued in the absence of IPCEI CIS, the Commission concludes that the notified aid individual measures are necessary to induce a change in the aid beneficiaries' behaviour in accordance with section 4.1 of the IPCEI Communication.

3.3.3.1.2. Proportionality of the aid

(318) According to point 32 of the IPCEI Communication, in the absence of an alternative project, the aid amount may not exceed the minimum necessary for the aided project to be sufficiently profitable, for example by making it possible to achieve an internal rate of return corresponding to the sector or company- specific benchmark or hurdle rate. According to point 33 of the IPCEI Communication, the maximum permitted aid level is determined with regard to the identified funding gap and to the eligible costs as set out in the Annex to the IPCEI Communication. The discounted value of the notified aid amounts cannot exceed the funding gap and their nominal value cannot exceed the eligible costs (as reported in section 2.7.2).

(319) The Member States have submitted, for all participating undertakings, detailed calculations of the eligible costs for their individual projects as well as detailed funding gap calculations.

<u>Assessment of eligible costs</u>

(320) For all the individual projects, the eligible costs must fall within the categories listed in points (a) to (h) as set out in the Annex to the IPCEI Communication.

(321) In order to assess the eligibility of the costs associated with the individual projects' R&D&I phases, the Member States demonstrated, firstly, that the eligible costs support research activities that aim at delivering a high innovation

level, and that the activities are not limited to merely enabling an incremental evolution of already existing cloud and edge technologies (see recitals (288) to (290)). They also demonstrated that the eligible costs are limited to the extent and for the period of the projects.

(322) Second, in relation to the R&D&I component of the FID activities, the Member States submitted that all beneficiaries have provided an adequate demonstration of the very important (in quantitative and/or qualitative terms) R&D&I activities in their FID, which constitutes an integral and necessary element for the successful implementation of their individual projects. Each of the individual projects concerns a new product with high R&D&I content or a fundamentally innovative service, or both (see recital (291)) and is not a mere regular upgrade, without an innovative dimension, of existing solutions, or a development of newer versions of existing products, services or technologies.

(323) The Member States also demonstrated that the FID activities result from a preceding R&D&I activity. Within the FID phase of the projects, additional important R&D&I will be carried out, which is necessary to test, scale up, mature or validate outcomes in real-world scenarios and conditions so as to meet the requirements for going into mass production (such as the ability to operate at scale and efficiency in pre-commercial pilot environments, achievement of the required quality of output, testing and adaptation of the performance of products and services on the basis of the technological feedback obtained from downstream industries and use cases executions, remedy bugs or errors, requiring the solutions to be further developed and adjusted).

(324) The FID phase for the projects included in IPCEI CIS corresponds to a phase in which the aid beneficiaries start to test and validate their solution (product or service) in realistic scenarios. Aid beneficiaries provide pre-commercial outcomes to selected potential customers and use cases to verify and validate the outcomes' quality and performance in real world conditions. Typically, under those conditions new issues related to the results' applicability, as well as limitations or hidden issues are revealed only thanks to the relatively larger-scale operation and complexities arising from "hands-on" use. At this stage, the solution might need to be corrected or developed further through additional important R&D&I activities. During the FID phase, numerous trial runs and a critical number of testing and experimentation scenarios are to be performed. This verification and validation process is particularly important and needed in the development of any IT system and solution, and in particular for the edge and cloud solutions resulting from IPCEI CIS projects. It serves to ensure that the solution meets the requirements, minimises the chances of defects and failures, especially in times of operation, and adheres to the defined quality and performance targets).

(325) For FID activities in the form of use cases the Member States demonstrated that the eligible costs comply with additional conditions, namely: i) the outcomes of the R&D&I phase of the project are integrated into the FID use cases; ii) the use cases pose specific implementation challenges with demonstrated innovativeness ambition that significantly surpass the global state-of-the-art in edge and cloud computing technologies and their adoption; iii) the use cases have the potential to validate and demonstrate in real-world scenarios and in environments of sufficient technological complexity and scale, the applicability of R&D&I results at the required level of quality and efficiency. These activities relate to the introduction of processes that transfer the R&D&I part of the project's outputs into the FID phase and are critical for the functionality of the resulting solution considering the

most up-to-date publicly available information related to the different IPCEI CIS technologies and outcomes (including scientific and technical literature journals, corporate technical scientific publications, etc.).

(326) For FID associated with infrastructure elements and equipment (points (b) and (c) of the Annex to the IPCEI Communication), involved in both the R&D&I and FID phases of the projects the Member States demonstrated the necessity of these elements for the individual projects. To this end the following criteria were analysed: the nature of the infrastructure elements (e.g., edge nodes) specific for each project, the localisation and size of these elements, their capacity and their technical characteristics, including in relation to security and energy efficiency measures, their necessity for high availability mechanisms, as well as the possibility for alternative use of pre-existing infrastructure elements.

(327) If instruments and equipment or buildings and land are not to be used during their full useful life for the duration of the individual project, only the depreciation costs corresponding to the R&D&I and FID phases are considered for the calculation of the eligible costs. The Member States also demonstrated that the depreciation periods used correspond to good accounting practice generally applied by the participating undertakings.

(328) With regard to the operating costs (points (a), (d), (e), (f), (g) and (h) of the Annex to the IPCEI Communication), the Member States demonstrated that they are limited both in scope and in time by the R&D&I that the FID entails, because only those operating costs that constitute an integral and necessary part for the implementation of the R&D&I and FID activities of the individual projects have been included as part of the eligible costs calculation.

(329) The Member States demonstrated further that the FID phase does not cover mass production or commercial activities. The Commission examined whether the different beneficiaries have established KPIs (e.g., reliability of software, latency, compatibility, energy consumption, environmental impact, maturity, etc) for identifying the moment in time when they reach a mass production readiness. Any costs relating to the development, occurring after the KPIs described above have been met, are not included in eligible FID costs and are not included in the eligible costs represented in Tables 4 to 11, under recital (186). In particular, any initial sales during FID are limited to and aim at obtaining necessary feedback looped back into additional R&D&I efforts to resolve the identified crucial issues before transition to mass production after the end of the FID phase (see recital (291)) and thus do not correspond to commercial activities, either in quantitative or qualitative terms. Conversely, years for which high volumes of sales were already planned or when sales occur after product qualification are not included in the FID and excluded from the eligible cost calculations summarised in Tables 4 to 11, under recital (182), given that such sales would point to commercial activities ([59]).

(330) In sum, the Commission has assessed the cost information provided by the Member States for each participating undertaking as summarised in Tables 4 to

([59]) According to footnote 24 of the IPCEI, "[l]imited sales, when necessary, in the specific sector, related to the testing phase, including sample or feedback or certification sales, are excluded from the notion of 'commercial activities'".

11, under recital (186), and finds that it meets the conditions set out in the Annex to the IPCEI Communication. As further indicated in Tables 4 to 11under recital (186), the nominal State aid amounts of each project remain below these eligible costs.

Assessment of funding gaps

(331) The funding gaps of the individual projects, as submitted by the Member States, demonstrate the funding necessary for the individual projects. The Member States must further demonstrate for each individual project that the discounted values of the State aid amount (using the WACC of the individual project as the discount factor) does not exceed the discounted funding gap for each individual project. To this end, the Commission reviewed in detail the funding gap calculations provided by the Member States for each aid beneficiary and verified the main assumptions in those calculations, as explained below.

(332) In the absence of a credible, sufficiently substantiated alternative project (see recitals (313) to (315) above), the funding gap, as set out in point 33 of the IPCEI Communication, is equal to the difference between the positive and negative cash flows over the lifetime of the investment, discounted to their current value on the basis of an appropriate discount factor reflecting the rate of return necessary for the beneficiary to carry out the project. The reference to the lifetime of the project means that the funding gap includes also the financial streams related to the mass production following from IPCEI CIS. The cash flows are discounted at the WACC of the aid beneficiary.

(333) The funding gap of each project at the level of each aid beneficiary is assessed in two steps:

(a) first, it is analysed whether point 34 of the IPCEI Communication is applicable. More specifically, whether the beneficiary faced a clear choice between carrying out either an aided project or an alternative one without aid (counterfactual scenario), which would be sufficiently specific to justify including the information on the expected NPV of the counterfactual project into determination of the aid proportionality; and

(b) second, the funding gap assumptions are reviewed and verified.

(334) Regarding the analysis of the existence of alternative scenarios, the Commission verified whether the information on the alternative project in the absence of aid that each undertaking provided a credible, specific and substantiated counterfactual scenario. For the counterfactual scenario, the Commission observes that the participating undertakings have reported the following options, in the absence of IPCEI CIS:

(a) Most participants would undertake a project in a similar technological area, somewhat comparable to the project under IPCEI CIS but with a different scope (e.g., delayed, smaller in size, lower level of technological ambition, for instance related to waiting for third parties to develop relevant technology, or only developing the technology when it proves sufficiently commercially attractive, etc.).

(b) Some participants would undertake no alternative project at all and would continue business as usual, which for instance means offering their existing level of energy efficiency or performance.

(335) For those beneficiaries that presented a counterfactual scenario, in which they would not undertake an alternative project, the Commission assessed the information that each relevant beneficiary had provided and, on the basis of that information, concluded that, in each case, the counterfactual scenario presented was credible. Consequently, for those projects, point 34 of the IPCEI Communication has not been applied.

(336) Where the participating undertakings claimed to face a clear choice between aided project and an alternative one, and provided positive NPV calculations for their alternative project, the Commission first analysed whether the alternative project was sufficiently specific, credible and substantiated. Due to the lack of sufficient substantiation in the form of relevant, contemporary internal company documents (e.g., reports, board presentations or minutes illustrating the choices, which the company contemplated at the time of deciding on the IPCEI CIS project), the Commission concluded that, for each of the projects concerned, the information provided on the financial aspects of the counterfactual scenarios was not specific and reliable enough to apply point 34 of the IPCEI Communication. As a result, point 32 of the IPCEI Communication has been applied and the Commission did not compare the expected NPV of the investment in the aided project and the counterfactual project for the purposes of determining the proportionality of aid.

(337) In the second step, the Commission assessed for each project the funding gap assumptions of the factual scenarios. Particular scrutiny was applied to the revenues, operating expenses, terminal value, WACC and tax assumptions.

(338) First, the Commission assessed whether the projections of each individual project include all of the revenues expected to be generated from their respective project. To this end, the Commission verified that the revenue streams are comprehensive, and thus in line with the technical characteristics of each of the individual projects, and accrue over the entire lifetime of the investment, spanning the expected life cycle of the respective project. The Commission also reviewed the underlying calculations and assumptions for projecting the revenues.

(339) In particular, the Commission verified that the funding gap calculations also included revenues from any synergies and/or cost savings generated under the individual IPCEI project of the aid beneficiary. For example, in most cases, these related to specialised know-how and skills developed under IPCEI CIS which could be used in other parts of the business, thus leading to increased sales or reduced costs at company level or other cost savings due to the IPCEI-related open-source software development.

(340) The Commission also assessed for each project that the funding gap calculations included any additional net cashflows generated by related products and/or services expected to be developed on the basis of the IPCEI CIS, provided that these would bring positive current value to the beneficiary. Such services include, but are not limited to, consultancy services, training services, other software products, additional paid features on the basis of open-source products, maintenance of the software, etc.

(341) Second, the Commission examined the operating expenses forecasts, including personnel costs, or costs of external services and energy, by reviewing the underlying calculations and assumptions (e.g. full-time equivalent estimations and cost per employee, contractual price with suppliers, etc.). Taking into account the projected revenues and operational expenses, the Commission assessed the expected profit margins of individual projects during their mass commercialisation phase. The Commission notes the relatively low profit margins of the individual projects, which are due to the open-source nature of the main outcomes of the projects. The Commission has verified, in such cases, that the level of margin was justified by precise and substantiated assumptions, and in line with similar projects or actors in the relevant market.

(342) Third, the Commission assessed that each individual project's projections include a terminal value that captures any remaining expected market value of the project after the end of the projections.

(343) Fourth, the Commission assessed that each individual project's WACC:

(a) corresponds to each undertaking's internal WACC. Deviations from this rule were assessed on a case-by-case basis.

(b) is calculated by applying the formula below:

$$WACC = \frac{E}{D+E} * \left(r_f + \beta * ERP\right) + \frac{D}{D+E} * (r_f + DP) * (1 - T),$$

where: E = equity, D = debt, r_f = risk-free rate, β = equity beta, ERP = equity risk premium, DP = debt premium and T = tax rate, and all of the parameters in the formula above, together with their sources and the methodology to determine them are provided.

(c) is in line with external benchmarks. To this aim, the Member States have provided benchmarks for the WACC's parameters based on publicly available data, with the aim of assessing the plausibility of the WACC ([60]).

(344) Finally, the methodology applied by each individual project to compute taxes has been assessed in order to ensure consistency across projects. The taxes did not increase the funding gap in an unjustified or disproportionate manner.

(345) In sum, all participating undertakings have calculated their funding gap in line with the IPCEI Communication and the guidance provided. In line with point 33 of the IPCEI Communication, the maximum permitted aid level for each individual project remains below the identified funding gap in relation to the eligible costs.

(346) In conclusion, the Commission considers that both the eligible costs and the funding gaps have been calculated in line with the IPCEI Communication. The notified aid amounts do not exceed the minimum of either in discounted terms the funding gap and in nominal terms the eligible costs (as reported in section 2.7.2).

([60]) The benchmarks identified by the Commission reflect the country and industry risks of the individual projects.

Claw-back mechanism

(347) In line with point 36 of the IPCEI Communication, the Member States must ensure that the individual projects will be subject to a claw-back mechanism, in light of the significant aid amounts involved.

(348) The Member States have submitted a mechanism, as described in section 2.9 and in Annex I, which provides an additional safeguard to ensure that the State aid remains proportionate and limited to the minimum necessary. The claw-back mechanism enables the Member States to reclaim a share of the profits if the project is more profitable than initially forecasted. The claw-back mechanism, which applies only to projects where the notified nominal aid amount is higher than EUR 50 million ([61]), covers almost half of the participants and more than 85% of the authorised State aid.

(349) By limiting the share of the extra profits that can be clawed back up to 75% of the extra profitability (see Annex I), the claw-back mechanism notified by the Member States ensures, as provided for by point 36 of the IPCEI Communication, a balanced distribution of additional gains between the Member State and the beneficiaries when the project is more profitable than forecasted as it maintains strong incentives for beneficiaries to maximise their project performance, while also ensuring that the aid granted under IPCEI CIS does not, in reality, exceed what is necessary to achieve IPCEI CIS' objectives.

(350) In order to achieve this balance, the claw-back mechanism notified by the Member States will apply only to those investments which reach, based on the ex post cash flow results and of State aid disbursements, a rate of return exceeding the beneficiaries' cost of capital (specifically the beneficiaries' WACC, see Annex I) or a surplus as defined in recital (196).

(351) Moreover, the threshold of EUR 50 million applies also to SMEs. In light of footnote 30 of the IPCEI Communication, which states that "[f]or projects by SMEs, no claw-back mechanism needs to be implemented unless in exceptional circumstances, in particular in consideration to the amounts of aid notified for such projects", the Commission considers that the receipt of an amount of State aid of more than EUR 50 million (which could exceed the SME threshold for turnover ([62])), is an exceptional circumstance for an SME. Therefore, the

([61]) A threshold of EUR 50 million for the application of the claw-back is also in line with previous case practice, such as for example the IPCEI ME/CT (SA.101202), see footnote 38.

([62]) One of the conditions to qualify as an SME is that the undertaking's annual turnover must not exceed EUR 50 million, in line with the Annex I to the Commission Regulation (EU) No 651/2014 of 17 June 2014 Declaring certain categories of aid compatible with the internal market in application of Articles 107 and 18 of the Treaty, OJ L 187/1, published on 26.06.2014, as amended and in force ("General Block Exemption Regulation").

Commission accepts that a claw-back mechanism, which is limited by reference to the amount of the notified aid per participating undertaking per Member State, is more appropriate to avoid disproportionate administrative burdens than a mechanism based on the size of the relevant participating undertaking.

(352) In addition, where the notified aid may be cumulated with aid under other measures, Member States have put in place mechanisms to make sure that irrespective of the source of the funding (local, regional, national or Union funding), the total public support will not exceed the notified and approved aid amount under this decision.

(353) Taking into consideration the assessment of eligible costs and of funding gaps, as well as the existence of the clawback mechanism with appropriate thresholds as an additional safeguard to ensure continuous proportionality of the aid and a balanced distribution of additional gains, the Commission concludes that the aid to be granted by the notifying Member States is proportionate.

3.3.3.2. Prevention of undue distortions of competition and balancing test

3.3.3.2.1. Appropriateness

(354) According to point 42 of the IPCEI Communication, the Member States must provide evidence that the proposed aid measure constitutes the appropriate policy instrument to address the objective of the project.

(355) The Member States submit that State aid is the appropriate policy instrument to support IPCEI CIS. In their view, in light of the market failures to be addressed (as described in Section 3.3.2.2.2), and notably coordination problems, State aid is the most appropriate policy instrument to enhance coordination towards the achievement of an overarching goal, which is the establishment of the Multi Provider Cloud Edge Continuum. The Member States submit that alternative policy options, such as regulation, would not be appropriate as they would require significant coordination and agreement from all Member States, which would be a complicated and lengthy process. Also, although existing (or imminently foreseen) regulations, such as the Data Act, may yield positive results, they are not sufficient to address in full the market failures identified in section 3.3.2.2.2.

(356) The Member States further argue that the payment of direct grants constitutes the appropriate instrument, in particular in view of the coordination problems that need to be addressed. More specifically, the Member States submit that direct grants encourage the participating undertakings to commit to their projects for the achievement of common objectives. At the same time, the fact that the disbursement is, in most cases, spread over the years of the project incentivises the direct participants to bring their projects to a successful end.

(357) The Commission shares the Member States' views that given the relevant market failures and the ambitions pursued by IPCEI CIS, the public support through the notified State aid measures constitutes an appropriate policy instrument to address its objectives of IPCEI CIS. The use of repayable advances does not constitute an appropriate aid instrument in cases such as that of the case at hand, because it would not increase the project's profitability to a level that justifies the undertaking carrying it out. Direct grants, instead, allow the undertakings to reach a sufficient rate of return from the project that justifies its execution. The funding

gap assessment and the introduction of the claw-back mechanism further ensure that the aid granted in the form of grants remains proportionate and does not result in overcompensation for the beneficiary. Furthermore, IPCEI CIS aims at overcoming significant coordination failures, for which joint and aligned efforts are necessary. The success of individual projects depends to a large extent on the implementation of coordinated actions of all participating undertakings. Grants allow the projects to reach a sufficient level of profitability and provide an incentive to the undertakings concerned to undertake the projects in the envisaged time frame and in a coordinated manner. As such, the market failures identified can only be sufficiently addressed with the use of grants. The Commission therefore considers the use of direct grants to be appropriate, pursuant to point 40 of the IPCEI Communication.

3.3.3.2.2. Prevention of undue distortions of competition and balancing test

(358) According to point 43 of the IPCEI Communication, aid can be declared compatible if the negative effects of the aid in terms of distortions of competition and impact on trade between Member States are limited and outweighed by the positive effects in terms of contribution to the objective of common European interest. The assessment of the potential negative effects of the aid under the IPCEI Communication needs to consider, in particular, the effects on competition between undertakings in the markets concerned, including up- or downstream markets, the risk of overcapacity, as well as risks of market foreclosure and dominance (points 44 and 45 of the IPCEI Communication).

(359) In order to analyse distortions of competition, the main technologies and services developed by IPCEI CIS projects need to be identified. They concern data processing services, including cloud and – increasingly – also edge offerings of various forms. Centralised cloud services offer large processing capabilities enabling complex processing on vast amounts of data but suffer from high latency, exposing limitations for fast and responsiveness data processing. Local and distributed edge components offer lower latency but have constrained computing capabilities and are thus not ideal for processing high volumes of data at scale. Cloud-to-edge services describe an intermediary software architecture connecting centralised cloud servers with local edge components. The Commission thus considers that these three market segments, namely cloud, cloud-to-edge and edge are concerned by IPCEI CIS and need to be considered for the competition assessment at the EU dimension.

(360) In the second quarter of 2022, approximately 72% of the data processing market in the European cloud segment was absorbed by Amazon Web Services, Microsoft Azure, and Google, the three hyperscalers. SAP and Deutsche Telekom are the leading European cloud providers, each accounting for 2% of the European market ([63]). They are followed by OVHcloud, Telecom Italia, Orange, and other national and regional players. The rest of the market is shared by smaller market participants.

([63]) https://www.srgresearch.com/articles/european-cloud-providers-continue-to-grow-but-still-lose-market-share

(361) The assessment of potential distortions to competition needs to take into account the particularities of the segments concerned and the participating undertakings involved.

(362) First, there is no risk of creating overcapacity, as the activities supported by IPCEI CIS do not result in the built-up of data processing capacities for commercial use. Instead, all activities, including the data processing facilities, are purely used for research and development, or testing and validation within the FID phase. Neither the amount of IPCEI CIS data processing facilities nor the type of setups used for R&D&I or FID are suitable to affect the continuous renewal process and, thus, the capacity of the data processing market. A future use of the IPCEI CIS research and development facilities for significant data processing capacities is unlikely as the facilities are, first of all, dimensioned only for the purposes of the individual R&D&I and FID projects, and also will be technically outdated by the end of the project. Moreover, by the end of IPCEI CIS, it is estimated that the data processing market in the European cloud segment will grow to about EUR 233 billion, while the data processing market in the European edge segment is expected to reach EUR 5.6 billion in terms of revenues ([64]). In addition, there is a policy objective to deploy 10 000 climate neutral highly secure edge nodes in the European Union by the end of 2030 ([65]). Instead of creating overcapacity, IPCEI CIS will help to address this demand by supporting the build-up of the necessary software architecture.

(363) Second, there is no risk of input foreclosure. This arises when an upstream supplier with a significant market position is able to soften downstream competition by profitably raising input prices or restricting supply for downstream rivals competing with its own vertically integrated downstream entity. In an open-source model, input foreclosure is less likely as research results are made available widely. As further described in the present recital, none of the European undertakings participating in IPCEI CIS will likely have a sufficiently strong market position upstream to profitably foreclose downstream rivals due to the strong presence of the hyperscalers along the Cloud Edge Continuum (see recitals (366) to (368)). In contrast, due to its open and interoperable nature, IPCEI CIS is likely to create a better level playing field compared to the current cloud industry or incentivise hyperscalers to foster interoperability in the Cloud Edge Continuum. Even if companies were to hold a significant market position along the Continuum, replicability of open-source software will help to ensure

([64]) Estimation based on data provided by the Member States at overall IPCEI level and in the competition assessment templates of direct participants.

([65]) See 2030 Digital Compass, footnote 4.

that the impact on competition will be limited by low barriers of entry into that market segment in the medium term.

(364) Third, there is no risk of customer foreclosure. This arises when a downstream undertaking with a significant market position reduces or stops procuring a substantial share of input from an upstream supplier competing with its own vertically integrated entity. To the extent that this reduces their ability and incentive to compete, downstream rivals may be faced with higher input costs. As further described below (recitals (366) to (368)), none of the European undertakings participating in IPCEI CIS will likely have a sufficiently strong market position downstream to profitably foreclose upstream rivals due to the likely strong presence of the hyperscalers along the value chain. Moreover, given the expected strong growth of the market, it appears unlikely that any single supplier in the value chain will rely to a very large extent on a single customer that cannot be substituted by an alternative customer in case lost.

(365) Last, there is no risk of crowding out effects. Crowding out effects can occur when public sector spending reduces or eliminates private sector spending in a particular industry. Instead, IPCEI CIS is likely to spur private investment due to increased competitive pressure on the hyperscalers and easier market entry for smaller European players. The large hyperscalers have limited incentives to invest in the interoperability of the Cloud Edge Continuum in the absence of IPCEI CIS due to the high profitability of their current proprietary system, while the smaller European players have limited incentives to invest in an open-source model in the absence of state funding, which does not generate future revenues to the same extent as the revenues generated by proprietary solutions.

(366) The Commission further assessed the potentially distortive impact of the State aid on competition based on the data provided by each beneficiary. The assessment was carried out at a granular market segmentation based on a 6-digit NACE Code ([66]) and the three market subsegments identified above, namely either Cloud, Edge, or Cloud-to-edge.

(367) For each market segment, the undertakings were asked to provide future and (if relevant) past EU-wide figures for (i) total turnover including project turnover, (ii) turnover of their five main competitors, (iii) project related turnover from outside activities relying on IPCEI participation such as related ancillary services, trainings, support, services etc., and (iv) total market turnover including the undertaking itself as well as its competitors. Based on the data provided, the Commission calculated two main indicators to assess the risk of State aid creating any potential competition distortions in the relevant market segment for the project, namely:

(a) the beneficiary's segment share assuming the IPCEI project takes place. This share is defined as the ratio of (i) the undertaking's annual turnover and (ii) total EU turnover in the years 2022-2030, providing a proxy for its future market position.

([66]) NACE: nomenclature of economic activities.

(b) the incremental gain in segment share, defined as the ratio between (i) the difference of the undertaking's turnover and project turnover and (ii) the total EU turnover, providing a proxy for the incremental gain in market position induced by the aid.

(368) Based on the two considered indicators, the Commission assessed whether any beneficiary currently holds or is projected to hold a significant market position in its respective segment. Even after including their project turnover as part of IPCEI CIS, none of the beneficiaries had a significant segment share and only a few beneficiaries exceeded a segment share of one percent during the considered time period. For those beneficiaries, the Commission further investigated either whether the beneficiaries were already in a strong market position, which, however, did not change significantly due to their IPCEI participation, or whether they gained significant segment share. According to the Commission's analysis, neither of these cases was prevalent in the data.

(369) The actual market share of each beneficiary might vary depending on how close the market segmentation chosen by the Commission approximates the actual competitive environment, in which the beneficiary is active. The Commission has undertaken sensitivity checks using different classifications for market segmentation, which, however, did not change the result.

(370) Finally, the Commission notes that the Member States confirmed in their notifications that their respective aid measures are not conditional on the relocation of a production activity or any other activity of the beneficiary from another Contracting Party to the EEA Agreement to the territory of the Member State granting the aid, pursuant to point 47 of the IPCEI Communication.

(371) In view of the assessment described above, a balancing of the expected positive effects of the aid outweighs its possible negative effects. On the one hand, the positive effects of the aid include concrete contributions of the individual projects under IPCEI CIS to addressing well-defined market failures (see section 3.3.2.2.2), as well as the objectives of the common European interest. On the other hand, potential competition distortions are limited given (i) the very small market shares of IPCEI participants, (ii) the very small increment in beneficiaries' segment shares due to their IPCEI participation, (iii) the limited market position of the beneficiaries vis-à-vis the hyperscalers, (iv) the open-source nature of most projects, and (v) the significant projected increase in demand resulting in no risk of overcapacity.

3.3.3.3. No breach of any relevant provision of Union law

(372) State aid cannot be declared compatible with the internal market, if the supported activity, the aid measure, or the conditions attached to it entail a violation of relevant Union law ([67]) (see recital (193)).

(373) Based on the information submitted by the Member States, the Commission has no reason to consider that IPCEI CIS would involve any breach of relevant Union law.

(374) In light of the above, the Commission considers that IPCEI CIS does not infringe relevant Union law, and that the condition of point 10 (c) of the IPCEI Communication is fulfilled.

3.3.3.4. Transparency

(375) The transparency requirements, specified in section 4.3 of the IPCEI Communication, are fulfilled (see recital (199)).

3.3.3.5. Conclusion on compatibility

(376) Based on the assessment under the IPCEI Communication, the Commission concludes that the notified aid measures are compatible with the internal market pursuant to Article 107(3)(b) TFEU.

3.3.4. Reporting obligation

(377) According to point 52 of the IPCEI Communication the execution of the project must be subject to regular reporting ([68]).

(378) As notified by the Member States (see recitals (199) and (200)), the execution of IPCEI CIS will be subject to annual reporting by the participating undertakings and the Member States. This reporting is twofold:

(a) first, the participating undertakings will report annually to the competent national authorities on the basis of a common reporting template, which will be developed jointly by the Member States and the Commission. The undertakings will report on the execution of their projects and in particular: the technological advancements achieved; progress on R&D&I and FID deliverables, as well as on sustainability, security and integration; progress on spillover activities (including on the commitments to provide access to infrastructure elements); the uptake of developed solutions by users and other market players, such as SMEs and public entities; compliance with the principle of "do no significant harm"; the progress

([67]) Judgement of 31 January 2023, European Commission v Anthony Braesch and Others, C-284/21 P, EU:C:2023:58, paragraph 96.

([68]) The participating Member States which intend to provide funding under the Recovery and Resilience Facility (RRF) are also bound by the reporting requirements that apply under that legal framework. It is clarified that the reporting obligations established by this decision are in addition to and independent from the RRF-related reporting obligations. However, the fulfilment of both sets of reporting obligations may be aligned in timing, to streamline administrative procedures of the Member States.

achieved and the status of effective collaborations with other IPCEI partners.

(b) second, the Member States will provide annually a summary report of the undertakings' execution of their activities, as well as on the progress of IPCEI CIS as a whole to the Commission, on the basis of a reporting template. This reporting will cover: the implementation of the project management plan, associated risk mitigation plan and sustainability plan; progress as regards key performance indicators and deliverables of the integrated project; progress on spillover effects and effective collaborations at the level of the integrated project; progress and status of technology developments; compliance with the principle of "do no significant harm"; progress on sustainability and security aspects of the integrated project.

(379) Further, the concerned Member States have agreed to report to the Commission on the application of the claw-back mechanism (see Annex I).

(380) The Commission therefore considers that the reporting obligation on the execution of IPCEI CIS is fulfilled.

4. CONCLUSION

In view of the above and in light of the notifications of the Member States, The Commission has accordingly decided:

- not to raise objections to the aid on the grounds that it is compatible with the internal market pursuant to Article 107(3)(b) TFEU.

If this letter contains confidential information which should not be disclosed to third parties, please inform the Commission within fifteen working days of the date of receipt. If the Commission does not receive a reasoned request by that deadline, you will be deemed to agree to the disclosure to third parties and to the publication of the full text of the letter in the authentic language on the Internet site: https://competition-cases.ec.europa.eu/search?caseInstrument=SA.

Your request should be sent electronically to the following address:

European Commission,
Directorate-General Competition
State Aid Greffe
B-1049 Brussels
Stateaidgreffe@ec.europa.eu

Yours faithfully,

For the Commission

Didier REYNDERS
Member of the Commission

ANNEX I

CLAW-BACK MECHANISM

The aid is capped in nominal terms by the notified and actual eligible costs. Member States will also ensure that the discounted value in 2023 terms of the aid (using the notified WACC as a discount factor) will not exceed the notified funding gap.

The claw-back mechanism will apply to those aid beneficiaries for which the nominal aid amount received, per Member State, is above EUR 50 million. ([69])

The basis for the claw-back mechanism will be *ex post* financial data, which have been subject to annual approval by an independent auditor. It will be implemented according to national framework conditions for grant agreements through obligations (including a perpetuated exploitation plan ([70])) of the eligible beneficiaries laid down in the national grant agreements. For this purpose, separate analytical accounting will be required from the aid beneficiaries in the relevant Member State for their individual project or projects.

Starting the year of completion of the eligible R&D&I/FID-phase, and thereafter, every year "i" until the end of the project ([71]), a surplus, denoted $Surplus_i$, will be computed as the sum (positive or negative) of the net present value, interest-adjusted to year "i" (using the notified WACC as an interest-adjustment rate), of the actual audited post-tax cash flows CF_k (including all costs and revenues, State aid disbursements and additional activities ([72]); and excluding financing cash flows) from 2023 to year "i". ([73])

([69]) Notified individual project(s), which subsequently are clearly determined as unsuccessful by both the aid beneficiary and the Member State – in particular, with regard to entrepreneurial decisions (e.g., the notified technology will not be pursued further) or due to financial reasons (e.g., the aid beneficiary cannot raise his own share) and are thus terminated before the end of R&D&I/FID phase, will not be subject to the claw-back mechanism. In such a case, the Commission will be informed by the Member State concerned within two months following the decision to terminate the notified individual project/projects.

([70]) The Exploitation Plan of the undertaking subject to claw back comprises of (a) an exhaustive list of the specific products and services or other forms of economic exploitation (incl. additional activities according to footnote 4) – points b), c) and d)) the project results will lead to within (b) the timeframe that is projected in the respective funding gap templates of the individual projects and (c) the exploitation model of the specific products, services and other forms of economic exploitation. The Exploitation Plan is part of the reporting of the Direct Participant until the end of the projected timeframe and will annually be updated.

([71]) The end of the project is defined as the last year that has been considered in the notified funding gap analysis for the relevant individual project.

([72]) For the purpose of the claw-back mechanism, given the characteristics of the IPCEI CIS, cash flows considered should also encompass the cash-flows of the following activities: a) additional public financial contributions – including any other State aid measure or public funding - in relation to the same eligible costs of the individual project, b) any cost savings and synergies in other parts of the company depending on the results of the individual project, c) related or adjacent products and services depending on the results of the individual project, d) maintenance or upgrading of products or services depending on the results of the individual project. The above-mentioned cash flows must be identified, quantified and reported by the company to the MS by means of an exploitation plan, updated on an annual basis until the end of project. If the company provides evidence that having done the project has a negligible impact on the above-mentioned cash flows, compared to a situation where the company would not have done the project, then these cash flows do not have to be taken into account within the claw-back.

As a formula, the surplus in year *i* would be represented as follows:

$$Surplus_i = \sum_{k=2023}^{i} CF_k \times (1 + WACC)^{(i-k)}$$

The claw-back mechanism only applies in case of positive surplus. *Surplus$_i$*, if it is positive, will be multiplied by an allocation ratio *ShareState$_i$* defined as the lesser between 75% or the net disbursed State aid from start of works to year "i" divided by the verified eligible costs from start of works to year "i" (both expressed in nominal terms)

$$ShareState_i = \min\left[0.75; \frac{\sum_{k=2023}^{i} Disbursed\ State\ aid_k}{\sum_{k=2023}^{i} Eligible\ costs_k}\right]$$

Letter of credit

A letter of credit (by a reputable financial institution having investment grade rating from a first-rank rating agency) should cover the repayment obligation at the end of the project by the aid beneficiary, from the first year of positive surplus.

The secured amount guaranteed by the above-mentioned letter of credit should be at least equal to an amount ensuring that the two following principles are fulfilled:

1) The secured amount must never be negative (initial balance equal to zero);

2) The secured amount must every year correspond to the lower of the following, if positive:

   - the *Surplus$_i$* multiplied by *ShareState$_i$*;

   - The net present value, interest-adjusted to the year "i" in which the surplus is computed, of the actual State aid disbursements between 2023 and that year "i". For all the disbursements before that year "i", the discount factor will be the Union reference rate applicable to the Member State concerned according to the Commission's communication on setting the reference and discount rates ([74]) applicable at year "i", increased by 100 basis points, between the corresponding disbursement and year "i".

An amount equal to the final secured amount, after the last application at the end of the project, will be transferred to the Member State.

The application of the claw-back mechanism will be reported by the relevant Member State to the Commission, including the aid beneficiaries' exploitation plans and their assessment by the Member State, within two months following the calculation of the surplus and until the End date.

([73]) For inputs and outputs for which a market price can be computed, if the ex post figures of the project, which have been subject to annual approval by an independent auditor, significantly differ from market prices, evidence shall be provided by the aid beneficiary to duly justify the gap between the market price and the figures of the project. In case of insufficient evidence, the relevant market price shall be used in the figures for the application of the claw-back mechanism.

([74]) OJ C 14, 19.1.2008, p. 6.

Account with annual transfers

Alternatively, the Member State, instead of the letter of credit system described above, may opt for an account-based system. This system will apply exclusively if the two following conditions are both met: a) the account to be used for the purpose of applying the claw-back mechanism is not under the control of the aid beneficiary; and b) computations and transfers to/from the account by the aid beneficiary must take place at least every year until the end of the project ([75]).

The balance of that account should never be negative and no transfer by the Member State to the account shall take place at any time.

This account-based system must not be more favourable from the aid beneficiary perspective than the letter of credit system ([76]) and should ensure comparable results.

The annual application of the claw-back mechanism will be reported by the relevant Member State to the Commission, including the aid beneficiaries' exploitation plans and their assessment by the Member State, within two months following the calculation of the surplus and until the End date.

([75]) The transfers to/from the account must take place not later than within the two months following the calculation of the surplus.

([76]) Excluding the specific administrative costs of a letter of credit, as well as fees and deposit interests related to an account.

ANNEX II

TABLE OF INDIRECT PARTNERS

MS	Indirect Partners	Type ([77])
BE	e-BO Enterprises	SME
BE	ENGIE Laborelec	LE
BE	ThreeFold Tech NV	SME
DE	ADVA Optical Networking SE	LE
DE	Airbus Operations GmbH	LE
DE	DB Netz AG	LE
DE	DE-CIX Management GmbH	SME
DE	Diehl Aerospace GmbH	LE
DE	elevait GmbH & Co. KG	SME
DE	Ericsson GmbH	LE
DE	Fachhochschule Dortmund	RO
DE	IONOS SE	LE
DE	LIMEBIRD GmbH	Startup
DE	Lindner SE	LE
DE	N+P Informationssysteme GmbH	SME
DE	Rheinmetall Technology Center GmbH	LE
DE	Robert Bosch GmbH	LE
DE	Secunet Security Networks AG	LE
DE	SYSGO GmbH	SME
DE	WestfalenWIND IT GmbH & Co. KG	Startup
ES	GIGAS HOSTING SA	SME
ES	INDRA SOLUCIONES TECNOLOGIAS DE LA INFORMACION SL	LE
ES	MONDRAGON Corporación Cooperativa S. COOP.	LE
ES	Capital Energy Services S.L.U	SME
ES	Ericsson España S.A.U	LE
FR	Amadeus S.A.S	LE
FR	Amiral Technologies	Startup
FR	Armadillo	SME
FR	United Biometrics	LE
FR	CNRS UGA ERODS	RO
FR	CNRS IRISA	RO
FR	CNRS UT3 IRIT SEPIA	RO
FR	INRIA NANCY - GRAND EST	RO
FR	INRIA LILLE - Nord Europe	RO
FR	CGI France	LE
FR	UNIVERSITE DE LILLE	RO
FR	UNIVERSITE CAEN BASSE NORMANDIE	RO
FR	UNIVERSITE BRETAGNE SUD	RO
FR	Institut Imagine	RO
FR	Lacroix Electronics Cesson	SME
FR	No Blue Screen System	SME
FR	Ningaloo SARL	SME

([77]) The type of undertakings mentioned in this table are: large enterprises (LEs), small and medium enterprises (SMEs), start-ups and research organisations (ROs).

FR	Provenrun	SME
FR	RYAX Technologies	SME
FR	Lacroix Sofrel	SME
FR	UNIVERSITE DE VERSAILLES SAINT-QUENTIN-EN-YVELINES	RO
FR	CNRS LAAS	RO
HR	Infobip d.o.o	LE
HU	Recog.AI	Startup
HU	Ericsson Hungary	LE
HU	H1 Systems Mérnöki Szolgáltatások Kft.	SME
IT	ENEA, Italian national agency for new technologies, energy and sustainable economic development	RO
IT	Fondazione Bruno Kessler	RO
LU	DataVaccinator SARL	Startup
LU	Excellium Services S.A.	LE
LU	Infrachain a.s.b.l	SME
LU	itrust consulting	SME
LU	Luxembourg House of Cybersecurity (former securitymadin.lu)	SME
LU	Proximus Luxembourg S.A.	LE
LU	RHEA Group	LE
LV	ASPIRED, SIA	SME
LV	DATI Group, SIA	SME
LV	Institute of Mathematics and Computer Science University of Latvia (IMCS UL)	RO
LV	Tilde, SIA	SME
LV	Ventspils High Ventspils Technology Park	RO
NL	Aecorsis B.V.	SME
NL	Amsterdam Internet Exchange B.V.	SME
NL	BetterBe B.V.	SME
NL	BIT B.V.	SME
NL	Deerns Nederland B.V.	LE
NL	Eurofiber Nederland B.V.	LE
NL	i3D.net B.V.	SME
NL	Info Support B.V.	LE
NL	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO	RO
NL	Stichting Nationale Beheersorganisatie Internet Providers	SME
NL	Universiteit van Amsterdam	RO
NL	Universiteit Twente	RO
PL	Operator Chmury Krajowej sp. z o.o.	LE
PL	Politechnika Gdanska / Gdańsk University of Technology	RO
PL	Phoenix Systems sp. z o. o.	LE
Sl	Result d.o.o	SME
Sl	Hashnet d.o.o.	SME
Sl	Kontron d.d.	LE
SI	Internet Institute d.o.o.	SME
Sl	Iskra d.o.o.	LE
Sl	Bass d.o.o.	SME
Sl	Igea d.o.o.	SME
Sl	Zejn d.o.o.	SME
Sl	Pro-bit d.o.o.	SME
Sl	Telemach d.d.	LE

ANNEX III

GLOSSARY ([78])

Abstraction layer

An abstraction layer hides the underlying implementation details and complexity of a functionality, component, system or another layer and exposes only an interface with whom other elements can communicate.

Application Programming Interface (API)

An API provides an abstraction of the underlying implementation of a problem through a set of defined protocols and definitions. APIs hide the implementation details of how the application works but developers can expose those parts of their applications that need to interact with other components, services or third-party applications. APIs foster interoperability amongst systems and services thanks to this open and common specification.

Artificial Intelligence (AI)

AI refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world or AI can be embedded in hardware devices.

Backward Compatibility

Backward compatibility is defined as the ability of any hardware or software to use interfaces and data from older software versions (legacy software) or work with other hardware systems successfully. In hardware this is achieved when the new hardware can work with older versions (e.g. x86 microprocessors) while in software, this happens when the new version is able to communicate and operate with older versions of the software in a consistent and deterministic manner. Software and hardware can share data easily and use the same interfaces for communication successfully. It is considered achievable when software or hardware can read, format, write and update an older version or format.

Bare metal as a service (BMaaS)

BMaaS is a cloud computing service that provides users with direct access to physical servers without the virtualisation layer typically found in traditional cloud infrastructure. It offers the advantages of cloud scalability and automation while allowing users to have full control and customisation over the physical hardware, making it well-suited for high-performance and resource-intensive applications.

([78]) This glossary contains indicative explanations of the technical terms used in the context of this decision and does not provide legal definitions.

Cloud storage

Cloud storage is a service model in which virtual storage capabilities emulating physical storage is offered to the consumer.

Colocation

A colocation is a data centre facility offered by a third-party provider from which an organisation can lease or rent space to accommodate its racks of servers. These servers are however managed by the undertaking owning the servers and not by the renter of the space.

Container as a Service (CaaS)

A container is a software that allows to package all the necessary elements such as libraries, dependencies, application code and the complete runtime environment so that it can run and be deployed on any environment. CaaS solves the problem of applications developed in a certain platform environment and whose execution is restricted to that platform environment's specifications. CaaS frees the application, making it completely independent of the underlying platform and infrastructure, eliminating the dependencies thereof. Hence, container-based applications are portable and can execute in any execution environment.

Copyleft license

Copyleft licenses require that in case of redistribution or creation of derivative works these shall be under the same license as the original work. Furthermore, if code is modified or added to the original software these shall be shared with the community.

Cybersecurity

Cybersecurity is the collection of tools, policies, procedures, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment and organisation's as well as user's assets. Cybersecurity is the cornerstone of digital transformation and the need for it permeates all sectors, therefore it needs to be considered across a broad range of policy fields and initiatives. Cybersecurity must not be restricted to a specialist community of technical cyber experts. Cybersecurity must therefore be embedded across all domains of EU policy. Avoiding fragmentation and the need for a coherent approach while considering the specificities of each sector is essential.

Data centre

A data centre facility is a physical place to accommodate computing resources that collect, store, share, manage, and distribute large volumes of data. Data centres are designed to provide a controlled environment with advanced technologies like servers, storage, and networking equipment to ensure data reliability and availability.

Data Processing Infrastructure

The data processing infrastructure refers to the various components – including hardware, software, networking, services, policies, and more – that enable data consumption, storage, processing and sharing. A data infrastructure provides the foundation for an organisation to create, manage, use, and secure its data. It includes the

physical infrastructure of the data centre facility, the information infrastructure that encompasses the systems and environments that allow to create and support the data, and the business infrastructure for the high-level business systems.

Digital twin

A digital twin is a digital representation of a real-world system, product or process covering their whole lifecycle. Digital twins use real-time data and allow for simulations and tests of different situations in order to support in the decision-making or to identify inefficiencies for instance.

Edge Computing

Edge computing is a form of distributed computing where the data is processed closer to the data sources and to the user that created that data. Edge allows to address the problems of proximity, aiming to reduce latency, bandwidth and overhead for the centralised data centre while increasing responsiveness and ensuring a better throughput ([79]).

Edge-aware Kubernetes clusters

A Kubernetes cluster is a set of nodes that allow running containerised applications. A cluster is usually composed of a control plane, that manages the state of the cluster and the nodes, which is where the workload is placed. Edge-aware Kubernetes can be defined as the extension of Kubernetes to accommodate the specificities and constraints of edge nodes and services. Kubernetes is an open-source solution.

Enterprise Resource Planning (ERP)

ERP is a software that helps organizations to manage their day – to – day operations. An integrated ERP is a software system that allows to control different aspects of a business (e.g. customer relationship management, supply chain management, personal resources) from a single point in a seamless and integrated manner. This favours optimisation and efficiency.

Far edge nodes

Far edge nodes are edge facilities deployed on a location furthest from the cloud data centre characterized by a power capacity of up to 200 kW and a latency of <5ms.

Federated Cloud

Set of joint technical solutions and policy rules in order to foster pan-European interoperable EU cloud services, driving the take-up of more secure, interoperable and energy-efficient data centres and cloud services in particular for small and medium enterprises, start-ups and the public sector.

([79]) Throughput is a measure of how many units of information a system can process in a given amount of time.

Federation

A federation is a seamless collaboration of multiple cloud and service providers offering the customer an integrated vision of the offering.

GitOps

GitOps is a set of practices that allow to manage in an automated way the configuration of the infrastructure. GitOps extends good practices from DevOps, used in the software development and operation life cycle, seeking to apply them to the infrastructure code. The term GitOps stems from the use of Git code repositories.

High-Performance Computing (HPC)

HPC most generally refers to the practice of aggregating computing power in a way that delivers a much higher performance than the one that could be achieved out of a traditional server in order to solve large problems in science, engineering, or business.

Infrastructure as code (IaC)

IaC enables the automation of tasks related to the management, configuration, deployment and provisioning of infrastructure that otherwise would have to be performed in a manual way. IaC allows for an easier redeployment on different infrastructural resources offered by different providers.

Infrastructure as a Service (IaaS)

IaaS is the provision of computational power, storage and network as well as other fundamental computing resources to the consumer who is then able to deploy and run arbitrary software, such as services and applications. The consumer does not manage or control the underlying infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., ports, proxy).

Interconnection

Interconnection refers to the physical and logical linking of networks with equipment or facilities not belonging to the administrative domain of that network. This includes the interconnection of carriers, cloud service providers, content delivery networks, mobile and fixed-line network service providers, and other participants of the Internet and (edge) cloud continuum running networks (e.g., data centres, enterprise networks). The resulting composed infrastructure layer is a critical building block required for a multitude of network services, existing and new applications implementing various end-to-end scenarios on the Internet and on the (edge) cloud continuum.

Interoperable cloud and edge systems

Interoperable cloud and edge systems refer to a set of computational and data processing environments that can seamlessly communicate and work together, allowing data and services to flow between them without compatibility issues. These systems are designed to provide a cohesive and efficient computing infrastructure that combines the advantages of cloud computing and edge computing, while ensuring that they communicate and cooperate effectively.

Internet of Things (IoT)

IoT can be defined as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

Latency

Latency is the delay in the response time. A high latency results often in a low Quality of Service and poor user experience.

Layer

A layer refers to a distinct level or component within a software or hardware system that performs specific functions, often interacting with adjacent layers to provide a structured and modular approach to designing complex systems. Layers help in organising and isolating different aspects of a system, enhancing its efficiency and maintainability.

Machine Learning (ML)

ML is a type of AI, that seeks to provide computers the ability to learn without being programmed. ML works by collecting data, which are cleaned in order to have a valid set of data sets and these are used to trained the computer algorithms and models. These models are able then to identify patterns in available data and to apply the acquired knowledge to new data in an automated way. The larger a data set, the better even subtle relations in the data can be discovered. When it comes to using AI, data-rich environments also provide for more opportunities. This is because data is the way the algorithm learns about and interacts with its environment.

Meta-orchestration

Meta-orchestration can be defined as the coordination between cloud and edge orchestrating platforms, following an approach similar to “systems of systems”.

Multi Provider Cloud Edge Continuum

Edge computing takes place at the edge of the network close to IoT devices, however, not necessarily on the IoT devices themselves but as close as one hop to them. Edge computing is characterised by short latency in contrast to cloud computing where transmission of data, allocation of resources typically includes delays. Multi provider cloud edge continuum encompasses the integration, federation and orchestration of resources stemming from the network, any device, edge and up to the cloud and from multiple providers, such as network operators and cloud service providers. The multi provider cloud edge continuum shall be able to seamlessly integrate all these services and capabilities which are offered to the consumer in a transparent way.

Near edge nodes

Near edge nodes are deployed between the far edge nodes and the cloud data centres. These are characterised by a power capacity of up to 1 MW and a latency of <10ms.

Network as a Service (NaaS)

NaaS is a cloud service model in which the capability provided to the cloud service customer is transport connectivity and related networking services.

Open source

Open source refers to documents, software or technology that is made freely available to the public with its content or source code accessible, allowing anyone to view, modify, and distribute the code for various purposes, in compliance with the licensing scheme permissions. This collaborative approach encourages transparency, innovation, and community-driven development within the software industry and beyond.

Orchestration

Orchestration is the management and coordination of automated workflows across multiple cloud and edge providers. Orchestration facilitates a more efficient management of automation and workload distribution tasks as well as allocation of resources and ensures that these are executed in the correct order.

Operational Technology (OT) domain

The OT domain refers to the specialised technology and systems used in industrial and infrastructure settings to monitor, control, and manage physical processes, equipment and machinery. It encompasses the hardware and software solutions that are essential for the operation of (critical) infrastructure such as manufacturing plants, power grids, transportation systems, and more.

Permissive license

Permissive licenses allow for reusing and merging code with code under other licenses without any obligation to share any of the updates that have been incurred in the software. Developers can extend, update and change software with permissive licenses without further sharing. This allows for the creation of proprietary and commercial software.

Platform

A platform is an artefact that serves or enables other products or services. Digital platforms exist at many levels: they range from high-level platforms that enable a platform business model to low-level platforms that provide a collection of business and/or technology capabilities that other products or services consume to deliver their own business capabilities.

Platform as a Service (PaaS)

PaaS is the capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including the network, servers, operating systems, or storage, but has control over the deployed applications and possibly on the configuration settings for the application-hosting environment.

Private cloud

Private cloud is a deployment model where the resources are provisioned for a single organization in an exclusive manner. In a private cloud it is that organisation hosting the resources the one that manages, controls and maintains it, unlike under a public cloud deployment model where an external organisation manages the services and resources.

Quality of Service (QoS)

QoS is a set of mechanisms that prioritise and manage network traffic to ensure a certain level of performance and service quality for different types of data or applications. It is commonly used to optimise network performance, reduce latency and ensure that critical applications receive the necessary bandwidth and resources to operate effectively.

Reference architecture

A reference architecture in the field of software architecture or enterprise architecture provides a template solution for an architecture for a particular domain. It also provides a common vocabulary with which to discuss implementations, often with the aim to stress commonality and achieve interoperability. A software reference architecture is a software architecture.

Service Level Agreements (SLAs)

An SLA, signed between a cloud service provider and a customer, which describes the level of service upon which the service will operate. A cloud SLA typically includes attributes, also called service level objectives (SLOs), such as uptime or service availability, or response time, among other aspects.

Software as a Service (SaaS)

SaaS is defined as the capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings.

Spatial data

All data that refers to a particular geographic area or location is considered spatial data. Sometimes it is referred to as geographic information or geospatial spatial data.

Standardisation

Standardisation is the process of developing and promoting technical standards, which are later on agreed in committees and consensus groups. Norms and standards can ensure market penetration of new ideas as well as compatibility, interoperability and portability. De facto standards are those that are agreed conventions among the industry as they are extensively applied but that have not gone under a formal standardisation process. These standards often result from a dominant position in the market.

Technology stack

A technology stack is a set of applications, libraries, services and other tools that are used to develop and deploy an application. A technology stack often encompasses a back-end (the server side) and a front-end (the client-user side.

Unmanned aerial vehicle (UAV) technologies

UAV is an aerial device that is guided remotely with no pilot onboard and can fly in an autonomous way partially or fully. UAVs are often used in civil applications like precision agriculture.

Virtualisation

Virtualisation is a process that allows for more efficient utilisation of physical computer hardware and is the foundation of cloud computing. Virtualisation uses software to create an abstraction layer over computer hardware that allows the hardware elements of a single computer – processors, memory, storage and more – to be divided into multiple virtual computers, commonly called virtual machines (VMs).

Anything as a Service (XaaS)

Anything as a Service is the universe of all the cloud delivery services, as it is a generic definition of all delivery ways that exist and that might be created in the future. As such, XaaS covers all other connected cloud services like IaaS, PaaS, SaaS and many others.