BELLA II WHITE BOOK

BELLA II receives funding from the European Union through the Neighbourhood, Development and International Cooperation Instrument (NDICI), under agreement number 438-964 with DG-INTPA, signed in December 2022. The implementation period of BELLA II is 48 months.

BELLA II

Building the Europe Link to Latin America and the Caribbean

BELLA II White Book

Carlos E. Seaton Moore
Luis Eliécer Cadenas Marín

July 2023
First Edition

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I. Introduction

The general objective of the BELLA II project has been defined as: ***To strengthen and expand the Latin American and Caribbean (LAC) digital ecosystem, enabler of relationships and exchanges between Latin American and European enterprises, research centres, educational institutions, and academic networks, to contribute to achieving the region's strategic goals focused on strengthening education, science, technology, and innovation***. Such an objective will lead, in four years, to an expansion of the digital infrastructure available in LAC as well as to an increase in the collaboration with European partners and will also help to consolidate the platform for the exchanges needed for the formulation and execution of research, education, and innovation projects, impacting, and promoting the social and economic development of the region.

Since the seminal work performed in the EU projects "Digital Business Ecosystems (DBE; 2003-2006)" and "Open Philosophies for Autopoietic and Associative Digital Ecosystems (OPAALSS; 2006-2019)", there have been many definitions of digital ecosystems, as well as relevant research performed to design, build, and use them to enforce public policies for social and economic development, as well as to promote regional competitiveness, innovation, and technological development. The consensus is that a Digital Ecosystem (DE) can be defined as a combination of a specific technological infrastructure, the so-called "digital environment", and those entities or "digital components" (software, services, business processes or models, contractual frameworks, law, knowledge, etc.) which have been formalized, digitized, and transported within the ecosystem and which can be further processed by humans or by computers. Since there are always people –be they individual or collective players– involved in such an environment, it seems meaningful to complete this technical definition by adding a third aspect, namely the social community related to DEs. This working definition could be refined, but these three **elements** –**digital environment**, **digital components,** and **social community of players**– are inherent to all DEs.

Of the several research approaches followed regarding digital ecosystems, we find that of (Chang, and West, 2006; Chang, West and Hadzic, 2006; and Boley and Chang, 2007) to be the most relevant for the BELLA II project. These investigators proposed the existence of an analogy between biological and digital ecosystems. In that regard, DE was defined as an ***open, loosely coupled, domain clustered, demand-driven, self-organizing agent environment, where each agent of each species is proactive and responsive regarding its benefit/profit but is also responsible for its system.***

In accordance with Chang, West, and Hadzic (2006), Digital Ecosystems are agent-based (human or intelligent digital species), loosely-coupled (the participants are free to join the virtual community), domain-specific (the participants have similar backgrounds) and demand-driven (they choose that they want to join the collaboration and determine their requirements and expectations of the system) interactive communities which offer cost-effective digital services

and value-creating activities (every agent or digital species is doing positive things for the community) that attract agents to participate (it is this freedom and open environment that is attractive) and benefit from it.

The purpose of this document is to serve as a White Book conceived with the purpose of providing a conceptual background, as well as roadmap to guide the interactions which will take place among the stakeholders involved in the execution of the BELLA II project. Unlike traditional static documents, which remain unchanged once created, we intend for this White Book to be a living document. A document which will be regularly updated, edited, and improved to reflect the latest information, insights, and developments.

Considering the above, we encourage the reader to read the White Book with that mindset. By doing so we will enrich the open strategic dialogue process that will occur during the first year of the BELLA II project. Undoubtedly, your insights, knowledge, and experiences will contribute to the finding of solutions and to the creation of innovations in such dynamic and rapidly evolving fields of human centered digital transformations, education, and research, and Industry 5.0.

The Book will be divided in eight sections besides this one. The second section deals with connectivity and its role in the digital ecosystem. The third section presents a summary of the state of the art made taking the European digital system program as a reference. The fourth section describes the view of innovation within the BELLA II project. The fifth section presents the roadmap for the design and building of the DE. The sixth section provides a working definition of RedCLARA digital ecosystems and its implications. The seventh section presents the image of RedCLARA digital ecosystem and the relationships within its components. The eighth section presents the components of the DE infrastructure. The nineth section provides arguments regarding the governance to be followed to ensure the achievement of BELLA II project.

The final version of the White Book will be produced at the end of the project to include all lessons learned and recommendations for future projects.

II. Connectivity and its role in the digital ecosystem

Connectivity and Digital Ecosystems are closely related concepts that play a crucial role in modern technology and business. In that regard, connectivity is, to DE, the equivalent of the soil, air, and water in natural ecosystems. All digital ecosystems are supported and nurtured through it. Connectivity can be deficient or lacking in many ways damaging or limiting the capacity of the whole ecosystem because the connections are not strong enough to nurture and support the digital species or because connectivity is not irrigating in the same way or with equal strength all the digital environments.

In all those cases, the analogy with natural ecosystems is almost perfect. The past BELLA Programme helped to increase the connectivity between the Digital Ecosystems in Europe, Latin America, and the Caribbean. The BELLA II project will extend and strengthen this connectivity by

sharing infrastructures and by fostering an open strategic dialogue process to create value for as many stakeholders as possible through co-investing involving private-public partnership consortiums.

Because of the above, the BELLA Programme and the BELLA II Project are complementary initiatives that reinforce each other and point out an evolutionary notion of connectivity. On one hand, the BELLA Programme did provide the large submarine cable connecting Europe and LAC and made possible access to an extraordinary capacity for data sharing, processing, and analysis to the National Research and Education Networks and Digital Ecosystems (NRENs, NREDE). In other words, enabling the sharing of information, knowledge, and resources, could contribute to reducing the digital gap that separates the region from most advanced nations.

On the other hand, there is the consolidation that will occur because of the BELLA II project in strategic areas such as: ***innovation in the shared infrastructure, synergies among stakeholders' infrastructure, human centered connectivity, and meaningful connectivity all supported and enabled through a data-driven approach.***

II.1. Innovation in the Shared Infrastructure

The vast and growing investment needed to create or foster the connectivity required to nurture and support the DE can be optimized by sharing as much infrastructure as possible. There is a clear trend among telecommunication providers to share part of their infrastructures, like towers, to install equipment or co-investing in significant projects to lay down new robust subsea cables or new terrestrial links.

The existing competence between potential co-investors limits the sharing of infrastructure. Big telecommunication companies have the resources and capacity to make significant investments without cooperation with other competing organizations. Smaller companies are restricted from operating in broader markets due to this dominance. This market structure is not negative *a priori* since niche companies can attend underserved markets that are not profitable enough for the big companies.

The ELLALink cable project joined many stakeholders to attain the ambitious goal of connecting directly with a new subsea cable Europe with LAC. In this project, a public donor, the European Commission, committed a significant number of resources to increase the project's viability, setting a clear goal with this action and helping to convince other investors about the project's feasibility. It is an example of co-investment that helped us to achieve a very ambitious goal.

The BELLA II project will explore, through the open strategic dialogues process, the possibilities of innovating in the development of the shared infrastructure needed to achieve the general and specific objectives agreed upon. We expect to generate a shared infrastructure like the one shown in Figure 1.

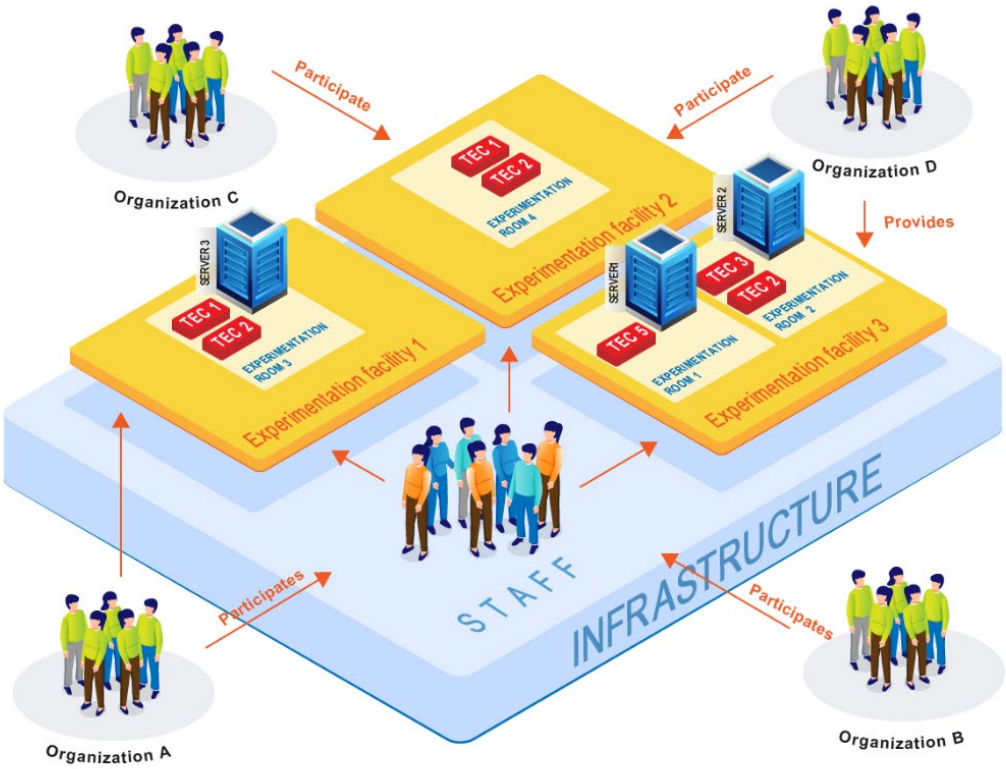

Figure 1: BELLA II Shared Infrastructure represents an innovative space where connectivity providers will explore, systematically, alliances and synergies to coproduce value along their industrial value chain.

As shown in the Figure, the shared infrastructure to be designed and implemented represents a space where connectivity providers would engage, systematically, in the explorations of alliances and synergies to generate and coproduce value to all stakeholders involved. The three bedrocks of such infrastructure are ***connectivity, cybersecurity, and digitization***.

During the first year of execution of the BELLA II project, we will make an inventory of resources, projects, and stakeholders that can engage in a collaborative action to share the available resources (financial, infrastructures, know-how, projects). It is our expectation that such inventory will help to identify and promote:

- Investment projects in connectivity infrastructure, ongoing or planned, that will deploy new connections and that can be swapped to get the connectivity required in the project's target countries.
- Projects for deploying optical, submarine, and terrestrial cables can be partially used to expand connectivity to BELLA.
- Organizations and companies that have infrastructures with the availability of dark or non-illuminated optic fibres, such as energy, transport, and other service providers.
- Existing infrastructures deployed by small operators.
- Community network initiatives.

- Other possibilities to deploy connectivity in cases where the traditional infrastructure is scarce (low-altitude satellites, microwaves, new technologies such as 5G).

The identification of these resources will allow exploring various alternatives to complete the connectivity to BELLA through the use or commissioning of infrastructures shared with other organizations (governments, companies, educational centres, and others) so that they widely benefit the community and society.

This process of search and identification of investment opportunities will allow BELLA II to structure a portfolio of fundable projects, which, aligned with the connectivity objectives, allow the participation of various additional financing sources to BELLA II in the deployment of this new connectivity.

Each developed investment project will lead to the establishment of a consortium of investors typically in the form of public-private partnerships that will establish the management and governance model of the shared infrastructure. In each case, RedCLARA will provide financial and technical resources and will ensure the portion of connectivity and participation in governance required to guarantee the country's access to the BELLA digital ecosystem.

II.2 Types of synergies among infrastructures that BELLA II seeks to identify during the Open Strategic Dialogues (OSD)

The synergies emerging as a result of the use of innovating in the **shared infrastructures** will allow various organizations, communities and persons to cooperate and share part of the infrastructure on which their connectivity services are based. Such types of synergy could occur by sharing resources such as optic fibres, cellular antenna bases, and others. By sharing common infrastructures, operators can reduce their investment and operating costs, which allows them to increase the resources available to develop other projects. Thus far, we have identified three key synergies:

1. Agreements for **exchanging capacities or mutual service provision** allow two or more connectivity providers to support each other in their services to have alternative connectivity routes that give them more resilience or geographical coverage.
2. **Vertical synergies** derive from the cooperation between various actors to provide connectivity services or based on them. In these cases, each one contributes components that allow the development of the service. In this type of synergy, we identify the agreements that connectivity providers can develop with energy companies to illuminate and share the available dark fibre, the capacities generated, and maintenance and operation costs.
3. **The integration of additional value-added services** to connectivity services makes it possible to create economic and social value by bringing services required by users, organizations, and communities that rely on connectivity but go beyond it. This is the case

of projects that are integrating telemedicine, educational, business development support, or innovation promotion services.

II.3 Meaningful connectivity

In this context, meaningful connectivity refers to using connectivity for an ulterior or broader purpose than the connectivity itself. This ulterior purpose derives from the interests, priorities, and plans of the different social actors that will benefit from said connectivity.

Meaningful connectivity in this context and following the natural ecosystem analogy means that the water, the air, or the soil is not wasted or contaminated but is used intentionally to populate the digital environment with as many species as possible. BELLA II looks to populate the digital ecosystems in Latin America and the Caribbean, with all kinds of organizations and individuals interacting with them or through them to create economic and social value in our countries, communities, and societies.

Meaning is a complex, multifaceted concept that refers to various aspects of persons, communities, organizations, and institutions. In the case of BELLA II, the search of meaning is related to questions such as: How could digital transformations technologies could contribute to the region socioeconomic development? How could the connectivity provided by BELLA II could be applied to foster collaboration, communication, coproduction of value and cocreation of innovations among stakeholders? How could the connectivity between different devices, systems, and data can be collected and analyzed in real-time, allowing for more informed decision-making and better overall ecosystems performance? These questions and others will be asked and treated during the OSD process.

This purpose of developing projects aiming at generating meaningful connectivity is possible in the context of BELLA II due to the Digital Alliance and the connectivity that BELLA provides to the digital ecosystems of Europe and LAC. To the extent that these areas of interest for connectivity projects are identified, the necessary actions to contribute to their development can be articulated within the framework of the Alliance.

In a natural ecosystem, the sun provides the energy that supports the living of all species existing within it. In a digital, business, knowledge, innovation, or financial ecosystem, it is the value generated that allows the growth, sustainability, and resilience of the whole.

Within the context of BELLA II, the value-laden meaningful connectivity will represent a game-changing strategy. In this sense, the searching and coproduction of value will be at the roots of all interactions planned and executed by stakeholders to bring forth their desired reality.

Each subsequent objective sought will be supported by the participation of organizations, companies, universities, and research centres that can and are interested in contributing to the development of these projects. An easy-to-understand example is meaningful connectivity to

support crop management and monitoring by integrating satellite data from the Copernicus Programme with information collected in situ from devices and data processing using Artificial Intelligence techniques and supercomputing capabilities articulated with the participation of organizations and individuals in Europe and LAC.

II.4 Human-Centric Connectivity

Digital transformation is the change associated with the application of digital technologies in all aspects of human society. Consequently, digital, and physical realities are increasingly intertwined and indistinguishable. Digital realities can be created at will and with increasing ease, while “physical” reality is less malleable.

Human-Centered Connectivity places the human being at the centre of digital transformation processes, as its maker and final reference. It seeks to maximize the impact of digital transformation for everyone and tries to help human beings fully understand and take advantage of the new reality.

It is more than bridging digital divides, improving access, or creating digital literacy. It needs the support of all the disciplines of human knowledge, especially the social sciences (philosophy, sociology, etc.), since up to now the focus has been overwhelmingly technical. The digital transformation to be human-centric requires a deep rethinking of what makes us human and how human nature will change due to this process.

For RedCLARA, the inclusive and human-centred digital transformation is a central capacity since it is related to our missionary purpose of supporting research and education, which, powered by a sizeable cybernetic infrastructure and the articulation of different actors, will provide the necessary environment to apply digital transformation technologies both to distributed knowledge management processes and to the launch of digital innovation solutions to support the socio-economic development of our regions.

Considering the above, it is RedCLARA´s conviction that the way forward is through open dialogues with stakeholders to co-create this new shared understanding of physical and digital interactions. It does not mean we underestimate the profound changes in productivity or the relevance of technical aspects, but we must look at them through the lens of "humanity".

Artificial Intelligence poses the most demanding challenges since its advances could lead us to a world where being intelligent is not just a characteristic of living beings. We will share it with computers and systems, leaving us with the need to find our place in that world. It means that we need to regulate the action of intelligent creatures other than ourselves with whom we are going to interact, and who might, in the future, surpass us in several of our distinctive capabilities.

We live in a world where few countries face technological and economic paradigm shifts, while others are close followers, but the vast majority are laggards. For the leading nations, the current

situation is one of transition. A transition caused by the uncertainties and increasing complexity introduced by radical new and pervasive technologies (digital transformation, cyber physics, nanotechnologies, biotechnology, microelectronics, cognitive sciences, social technologies, etc.) of opportunities and threats.

In addition, there are issues of social injustice, job inequality, environmental deterioration, the pandemic, and immigration issues. These issues are generating social volatility, anxiety, fragility and uncertainty among people and organizations and have called for finding global solutions to such pressing problems. The seventeen goals for global sustainable development proposed by the United Nations are examples of some of the expected solutions.

The digital transformation centred on the human being of RedCLARA is a strategic axis that serves as the nucleus around which our portfolio of programs and projects of innovative solutions in terms of the application of digital technology to find solutions to the problems of our time.

Finally, we want to emphasize the role of cooperation and collaboration. RedCLARA has an ethos based on cooperation; we sincerely believe that by working together, we can find solutions to humanity's most pressing challenges, even amid the diversity of interests and amid the competitive approach that sustains and promotes our social, political, and economic models. We are committed to building with our European partners a beacon of what cooperation and collaboration can offer us. The Digital Alliance between Latin America, the Caribbean, and Europe will be an opportunity to show how to build a better future together.

III. State of the art of the European digital ecosystem programme

The purpose of this section is to provide an overview of the state of the art of the meaningful and pioneering efforts done within the European Union to promote socioeconomic development based on the application of ICT technologies. Since the beginning, the major motivation of the EU was the creation of conditions allowing the approximately 90% of SMEs distributed along the members countries the access to knowledge and technologies needed to enhance their innovation capabilities, as well as their productivity and competitiveness. The challenge's posted in that regard involved the creation of ***Business Ecosystems*** characterized by **open standards**, **democratization of access to information sources**, totally **decentralized** environment following a **port-to-port (P2P)** approach. All this conceived with the purpose of **maintaining business autonomy** while protecting, at the same time, both **intellectual property** and the spaces for the creation of alliances **that allow exploiting market opportunities**.

Digital Ecosystems emerged from the research done as a novel approach for the catalysis of sustainable regional development driven by SMEs. The conclusions leading to the coining of the term Digital Business Ecosystems, as well as the implications of the approach are treated in a

seminal manner in the book Digital Business Ecosystems summing up the results of the DBE European Project (Nachira, Nicolai, Dini, Louarn and Leon in 2007).

Further research conducted within the realm of the OPAALS (2008-2010) project led to the building of an interdisciplinary research community in the emerging area of Digital Ecosystems, and to the development of an integrated theoretical foundation for Digital Ecosystems research spanning three widely different disciplinary domains: ***social science, computer science, and natural science***. The major claims that OPAALS made where that to achieve sustainable digital business ecosystems of SMEs and software components we needed to understand in depth the collaborative processes and ICTs that underpin the continuous creation, formalization, and sharing of knowledge in the form of business models, software infrastructure for e-Business transactions, and new formal and semi-formal languages. This project represented the first step to engage in a recursive, reflexive, and self-reinforcing community building process that hoped to culminate at the end of the project with an Open Knowledge community of research and innovation inclusive of all the stakeholders of digital ecosystems but mainly of academic institutions and SMEs.

During the technical and scientific research activities performed within the OPAALS project, a balance was sought between the role of formal and semi-formal languages in epistemic communities and in new Open-Source models emerging in public and commercial projects. In this regard, an attempt was made to develop a unifying evolutionary framework for language to base the evolutionary and adaptation characteristics of the digital ecosystems on the main medium of social constructivism: ***language***.

Within Europe, the growth of the digital ecosystems had to wait until the development of the ICT infrastructure needed to support them. The flagship of these efforts was the ***Internet of the Future***, a Program designed and implemented by the European Commission that involved two key components: the ***Internet of Services (IoS)*** and the ***Internet of Things (IoT)***. During a decade, approximately, the hundreds of projects executed within the Horizon 2020 framework contributed to the generation, consolidation, and growth of a seamless and interconnected network of services and devices, that are changing, significantly, the manners we innovate, we do businesses, we compete, we live, and we work.

In the year of 2016, the ***Digitizing European Industry (DEI)*** initiative was launched by the European Union (EU). Such initiative aimed at supporting the digital transformation of European industry and increasing the competitiveness of European businesses. The DEI initiative focused on several strategic areas, including:

1. ***Digital Innovation Hubs (DIH)***: Supporting the establishment of Digital Innovation Hubs across Europe, which are organizations that provide SMEs with access to advanced digital technologies and expertise.
2. ***Digital Platforms***: Developing common digital platforms to enable the sharing of data and services across different sectors and industries.

3. ***Skills and Training***: Investing in digital skills and training to ensure that Europe's workforce is equipped with the skills needed to thrive in the digital economy.
4. ***Research and Development***: Supporting research and development in key digital technologies, such as cybersecurity, artificial intelligence, and the Internet of Things (IoT).
5. ***Regulatory Framework***: Creating the conditions for the design and implementation of the public policies to support national and regional socioeconomic growth.

The ultimate goal of the Digitizing European Industry initiative was to help European businesses embrace digital technologies and drive innovation and growth in the European economy.

At the present time, the state of the art concerning the evolution of the European Digital Ecosystems is the result of the implementation of the 2021-2027 Action Plan conceived by the European Commission (EC) to emphasize the strategic role played by ***Digital Innovation Hubs*** concerning the support to the digital transformation processes needed to foster product advancement, process enhancements, and business models adjustments to the digital revolution (Sassanelli C, and Terzi S; 2022).

Because of the above, the EC defined the DIHs as organizations capable of providing support and assistance to companies (particularly SMEs, and start-ups) in improving their effectiveness and competitivity through innovations, fostering the employment of digital transformation technologies (European Commission, 2018a, 2018b). The EC also promoted cooperation among DIH networks, funding the establishment of extensive pan-European DIHs that can cover a wider spectrum of assets (capabilities, skills, technologies, and knowledge) and provide, also through the development and provision of dedicated digital platforms, a more complete set of services to their potential users (technology providers and users), for example, the networks of DIHs for the cyber physical systems (DIH4CPS) (Sassanelli et al., 2020a; Semeraro et al., 2021).

III.1. Relevance from the perspective of the BELLA II Project

Many of the projects selected within the 2021-2027 Action Plan of the EC regarding the DIHs are still in the process of execution, and others are just beginning. They constitute, however, the most advanced experience related to the operations of digital ecosystems and a source, in the short term, of best practices to be explored along the four years of execution of BELLA II. Additionally, they provide useful information concerning the strategic vision which will be explored during the conduction of the open strategic dialogue process; and could serve as a natural bridge for the exploration of collaborative efforts within the scope of the agreement for the Digital Alliance recently made between Europe and LAC.

In addition to converting the DIHs in one of the strategic axes for the socioeconomic development of the European Union, the EC also defined the key functions to be provided by them. These functions: ***networking, skills and training, test before investing and access to funding*** are in complete alignment with the general and specific objectives of BELLA II.

Regarding networking, Costa-Soria and Sassanelli (2021) have shown that in the context of *networked organizations*, such as Digital Innovation Hubs or Incubation ecosystems, a key activity is the design and configuration of the service portfolio. This service portfolio aggregates, and enhances in some cases, a wide, diverse, and complementary range of services from different providers, which are selected and organized according to the mission and value proposition of the networked organization.

At the present time, the state of the art of application of digital technologies to support socioeconomic development is represented by a set of models that have been evolving over the last four years. In that sense, it can be said that further research and development will need to be done not only from the conceptualization or epistemic point of view, but also from the gathering of the empirical evidence required for the establishment of a consolidated practice. In Table 1 we make a brief description of the models proposed and their evolution.

Table 1: Models that have been proposed for the support of DIHs to SMEs and their characteristics.

Model	Characteristics
Ecosystem-Technology-Business (ETB).	Model described in 2019 (Butter et al) which was developed based on the accumulative experience gained from the execution of the projects within the initiative I4MS (ICT Innovation for Manufacturing SMEs) launched in 2016. These projects, funded by the European Union, aimed at supporting and promoting the digital transformation of manufacturing, as well as strengthening the competitiveness of European SMEs.
Ecosystem-Technology-Business-Skills-Data (ETBSD).	Model proposed in 2020 as an evolution of the ETB. It posited that those five elements (Ecosystem-Technology-Business-Skills-D) are tightly interconnected and constitute the essential components needed to help individuals, communities and organizations navigate the rapidly changing and increasingly complex landscape of modern business and technology in the knowledge economy.
Data Driven Business, Ecosystem, Skills, and technologies (D-BEST).	The D-BEST model has been proposed by Sassanelli and Terzi (2022). The model triggers the identification and materialization of service-based collaboration processes among DIHs based on their service portfolio analysis and supports the modelling of Collaborative Networks 4.0, in which DIHs are a strategic player because of their 'by-design' innovation characteristics.
Data Incubator for organizing a service portfolio (REACH).	This model, developed by Costa-Soria and Sassanelli (2022) describes the experience of the REACH Data Incubator for organizing its service portfolio, and how the D-BEST service model was applied to implement its catalogue. Within the REACH model, the service portfolio involves technology training and support services, business development services, and access to finance services, with the goal of preparing their customers (entrepreneurs and startups) to face a very competitive market.

Evidently, the level of investments, the numbers of projects, and the dimensions of the testbeds created by the Ciber-Physical Systems built by the European Union to support the application of digital transformation technologies to industrial development are far beyond those of the BELLA II project. However, the knowledge generated by these experiences is highly relevant and will be applied during the design of the solutions by stakeholders involved in the OSD process, and during the implementation of the selected solutions.

The D-BEST reference model proposed by Sassanelli and Terzi, included in Table, 1 offers the most attractive and interesting solutions for the networked organization that RedCLARA is in general, and for the project BELLA II in particular. According to these researchers, the processes of providing, by the networked DIHs, services capable of fostering economic growth and industrial development must be structured into five macro-classes, types, and classes. Table 2 gives an example, in a non-exhaustive manner, of three of the five macro-classes proposed by Sassanelli and Terzi. Namely: the macro-classes ***Ecosystems-Technology-Business***.

Table 2: Ecosystems, Technology and Business macro-classes.

Macro-classes	Purpose	Serve Typologies	Classes of Services
Ecosystems	**The digital infrastructure to provide support to the relationships, exchanges and interactions taking place among stakeholders.**	• **Community building.** • **DIH Innovation development.** • **Ecosystem Governance.**	• Participation and involvement of communities, professionals, and organizations. • Communications. • Brokerage. • Technological surveillance. • Strategic thinking and visioning. • Impact evaluation of services provided. • Strategic management of ecosystem.

Technology	**The hardware and software needed for the support of process within the digital ecosystem architecture, as well as the social and technical interactions among stakeholders.**	• **Idea management and materialization.** • **Contract Research.** • **Provision of infrastructure.** • **Technical support on scaling up.** • **Verification and validation.**	• Proof of concepts for the validation of innovative ideas. • Technology readiness assessments. • Provision of platform technology infrastructure. • Provision of access to laboratory facilities. • Exploratory prototyping to demonstrate the viability of creative ideas. • Prototyping and development of innovative solutions before the generation and launching to the markets of innovations. • Technological prospective of emerging technologies.
Businesses	**The business support occurs in advanced scenarios detecting, modelling, and supporting viable business models, proposing fundraising services.**	• **Incubation, acceleration support.** • **Access to finance.** • **Business training and education.** • **Project development.**	• Access to basic technological facilities created with the purpose of supporting the incubation of firms. • Access to spaces for networking and exploration of business opportunities among stakeholders. • Connection to funding resources and venture capital at the regional, national, and international environment. • Training in business management and in the formulation and development of business models. • Support in cooperation and collaboration among stakeholders for exploiting identified business opportunities.

The three macro-classes shown in Table 2 constitute an evolution and a significant improvement of the ETB model developed in 2019. These macro-classes allow the generation, combination, and recombination of the knowledge and technology-intensive business services provided by the

DIHs to support SMEs in their efforts to become more competitive, productive, and innovative thanks to the use of digital transformation technologies.

The major difference between the ETB and the D-BEST reference model is the inclusion of the macro-classes ***Skills and Data***. Table 3 presents, in a non-exhaustive manner, the characteristics of these macro-classes that were identified during the development of the model by Sassanelli and Terzi.

Table 3: Skills and Data macro-classes

Class	Purpose	Serve Typologies	Service Portfolio
Skills	**To assess the status quo of those companies willing to approach digitization concerning both process/organization and skills maturity and to then define a consistent roadmap to enhance it. The second is to aid skill empowerment on one side through educational programs, up-skilling, and re-skilling training, and on the other through knowledge transfer mechanisms.**	• **Processes and organization maturity.** • **Human capabilities maturity.** • **Skills improvements.**	• Assessment of company readiness and maturity for Industry 4.0. • Definition of a technology roadmap based on the maturity assessment. • The assessment of human skills maturity regarding Industry 4.0. • Analysis and measuring of the gap between actual and desired situation of the SMEs. • The organization of dedicated human up-skilling and re-skilling training, courses, and workshops. • The definition of educational programs, allowing for the attraction and formation of next-generation talents. • The support for knowledge transfer through internal channels, structure contacts and collaborations.

Data	**The data macro-class is crucial for fully taking advantage of the potentialities of digital technologies through services related to diverse phases of the data life cycle: from data acquisition and sensing to data processing and analysis, up to decision-making and data sharing, also including aspects such as physical-human action and interaction.**	• **Data acquisition and sending.** • **Data processing and analysis.** • **Decision making.** • **Physical-human action and interaction.** • **Data sharing.**	• The provision of support in data acquisition through data in motion, models, and services. • Technology readiness assessments. • Support in data anonymization, confidentiality, encryption, and preservation services. • The provision of data spaces, data lake, linked data, distributed storage, and knowledge representation services. • The configuration and deployment of architectures for big data. • The provision and development of decision support services, including cognition, prediction and prescription, simulation, machine learning, reinforcement, DNNs and formal logics. • The provision and support of hardware and software architectures and components and the provision of connectors services.

By including the *skills and data macro-classes*, the researchers provided the reference model with the additional capabilities that the DIHs needed to acquire in order to support SMEs in the application and deployment of the cyber-physical systems and of artificial intelligence required to solve the challenges and exploit the opportunities offered by the digital transformation technologies. The macro-class skills, for example, ensure that the DIHs could help the enterprises in the training needed for the development of specific capabilities, in the operation of the test-beds demonstratives of the potentials of digital innovation, and in the design and implementation of the digital operational facilities required to convert ideas into innovations in processes, products and business models.

The data macro-class, through the five typologies shown in Table 3 allows the operation of the cyber-physical systems infrastructure associated with the application of digital transformation technologies. That is to say, the integration of physical systems, such as machines, sensors, and devices, with computing systems and human and artificial networks. We are witnessing a paradigm shift in the way we design, operate, and interact with the physical world. This macro-class, through the convergence of cyber and physical systems, contributes to the enabling of strategic processes such as informed decision-making, the creation of smart, connected, and distributed networks, enhanced machine leanings, and the support of human-centered digital transformation.

III.2. The D-BEST Reference Model as a Benchmark

The development of the D-BEST model has taken place through a methodology designed and implemented to ensure the participation of all stakeholders involved in the conversion of the DIHs into a powerful network of organizations specialized in the deployment of the strategies conceived by the European Commission to foster socioeconomic development. The application of such methodology allowed the exploration of the solutions from a highly interactive primary research process that involved the lines of actions shown below as described by Sassanelli and Terzi (2020).

Tailored and detailed service instances.

- The service provider (European DIH network, single DIH, technology provider company, and university and research centres).
- The service customers (technology end-user company, single DIH, technology/solution provider company, and university and research centres).
- The service output (e.g. events, financing, education, assessment, consultancy, assets and ideas sharing).
- The service value proposition (i.e. visibility, access to partners, funding, access to knowledge, market analysis, access to services, and collaboration).
- The EU DIH functions (networking, skills and training, test before investing, and access to funding).

As a reference model, D-BEST is a conceptual framework that provides a common language, concepts, and standards for describing and analysing the role of digital innovations, digital transformations technologies, and digital ecosystems in the development of the European knowledge economy. It is a structured representation of the key components, relationships, and processes of a system or process, and it serves as a guide for designing, implementing, and evaluating deployed solutions. A reference model is a representation, made at a high level of abstraction, of the relationships between the variables that originate and explain the functioning of a given phenomenon, process, or system (OASIS, 2006). Once produced, such a model can give rise to a variety of solutions, depending on the context of its application. From the perspective of the BELLA II project there are, within the characteristics of a Reference Model, two that are of interest:

- The Reference Model facilitates the integral or holistic understanding of the main variables that affect the behaviour of the process or phenomenon under study.
- A Reference Model is independent of the technologies that can be used to generate solutions within the phenomenon or context of study.

The first characteristic allows us to think and act strategically on the key variables that determine the process or system under study. This action is based on the best knowledge of the cause/effect relationships that originate because of the interaction between the elements or components that

produce a certain behavior. The second feature keeps open the possibility, not only to experiment with various technologies to meet the requirements of the Model, but also to produce a diversity of solutions adaptable to the evolutionary changes that the regions experience during its transformation and growth.

In other words, the Reference Model provides the basis for a systematic study of the variables that affect a given phenomenon, allowing both the expansion and the incorporation of emerging variables; and ensuring experimentation with methods and techniques adaptable to different problems within a specific field of knowledge.

Building a D-BEST as a reference model involved a collaborative and iterative process that required input from multiple stakeholders and experts in the field. The produced reference model satisfies the conditions of being flexible, adaptable, and scalable to meet the roles of the DIHs as organizations capable of contributing to the consolidation of the European digital and business ecosystems.

As a benchmark, the D-BEST reference model provides a framework that could be used to measure or evaluate the performance, quality, or effectiveness of the solutions conceived and implemented to meet the challenges created by the advent of digital transformation technologies. It offers, in other words, a starting point for: (i) the conduction of benchmarking exercises for the identification, contextualization and application of best practices; and (ii) the formulation of the actions plans to set the performance targets to be overcome to achieve the desired social, economic, and technological transformations.

In the case of the BELLA II project, such benchmarking exercise will be a learning process in which indicators will combined, when they can be measured and used, but above all, it will be an exercise focused on the deep understanding of the underlying processes behind the differences in performance between communities, organizations, countries, or regions. In this sense, we agree with Lundvall and Tomlison (2002) who proposed that the most appropriate approach to do the benchmarking exercise involves the development of good or best practices from what is known as "Intelligent Benchmarking". That is, a Benchmarking focused on:

- A comparative analysis whose emphasis is not on indicators, but on understanding the differences in the conduct of digital business and digital innovations processes that distinguish world-class operations of digital ecosystems.
- The conception of Benchmarking not as a process of competitive nature, but as a collaborative one. This agrees with the creation of a space for dialogue (face-to-face or virtual) where experienced, world-class networks could contribute to the understanding of the management of business processes from the desired levels of depth, productivity, and competitiveness.

As a first approximation, the process of conducting the intelligent benchmarking will draw, mainly, from the lessons learned through the European experience associated to D-BEST

reference model, but also from previous models and emerging practices discovered through technological surveillance. Specifically in learnings drawn when dealing with the aspects shown in the exhibit below.

1. The structuring of part of the OSD process in terms of identifying the macro-classes that could be relevant from the perspective of BELLA II project. For instance, ICT connectivity, meaningful connectivity, and service portfolios.
2. The exploration, based on the testbeds as one of the roles of DIHs, of similar or likewise organizational structures that need to be put in place in LAC to contribute to the solution of the digital transformation technologies challenges.
3. The designing of specific strategic dialogue workshops to explore with producers and consumers of services the conception and implementation of processes for the coproduction of value and the cocreation of innovations.
4. The designing of specific strategic dialogue workshops to explore with members of the digital alliances between LAC and Europe, the engagement on pilot projects for the prototyping and testing of the solutions to be developed by BELLA II.
5. The designing of specific strategic dialogue workshops with the participation of influential stakeholders to explore the policies to be implemented and the funding of them.

By working on the five aspects described above we will ensure that the macro, meso and micro dimensions that are crucial for the successful execution of BELLA II will be covered. At the macro level, we will be dealing with the strategic issues and will tend bridges, within the scope of the digital EU-LAC alliances, to the joint development of an international digital ecosystem capable of accelerating the application, within the region, of digital transformation technologies to foster socioeconomic growth.

The meso level will contribute to the identification of the organization infrastructures needed to implement the strategies derived from the macro. Thus, providing the capabilities required for policy deployment, as well as program funding and monitoring and evaluation of the process of building and operation of BELLA II digital ecosystem.

The micro level will contribute to the identification and empowerment of stakeholders that could be considered lead users. Those who will engage in the formulation of a pilot service portfolio, in the identification of opportunities to exploit them, and in the execution of projects showing the capabilities of BELLA II digital to induce processes of coproduction of value and cocreation of innovations.

IV. The view of innovation within the BELLA II project

The development of innovations and their implications will constitute, during the execution of BELLA II project, a crucial or critical success factors. This section of the White Book will deal with four major aspects: (i) the relevance of innovation within the BELLA II project; (ii) the connection between the digital ecosystem and innovation; (iii) different modalities of innovation to be developed by stakeholders involved in the execution of BELLA II project; and (iv) a brief summary of digital ecosystems relevant initiatives worldwide.

IV.1. The relevance of innovation within the BELLA II project

The relevance of innovation for the BELLA II project is stated in the general objective already described, and in the specific objectives (SO) of the project, which are:

1. To increase the adoption and use of digital transformation technologies to develop digital research and education solutions.

1. To intensify the cooperative relationships with European research and educational digital ecosystems to promote knowledge sharing, access to good practices, and the creation of dialogue spaces needed to design, formulate, and execute innovative research and education projects.

1. To engage with European initiatives such as the EU-LAC Digital Alliance to develop capabilities in applying digital transformation technologies to foster innovation in the public and private sectors.

The fulfilment of the listed specific objectives requires the exploration, experimentation, and development of several innovation modalities among the stakeholder involved in the BELLA II project. The first SO, for instance, calls for new manners to face the challenges created by the advent of digital transformation technologies regarding educational processes like those related to the intelligent university, as well as in the nature of the research processes to find solutions to the objectives of the global sustainable development.

Likewise, the second SO calls for experimentation with collaborative ways of knowledge management, relationship marketing, benchmarking, social and cognitive translations, as well as value coproduction to accelerate the incorporation of LAC countries into the digital society. For example, the formulation, negotiation, and execution of innovative pilot projects to develop the capabilities required to achieve the strategic vision defined by EU and LAC.

Finally, the third SO represents a vital area for the growth and sustainability of the EU-LAC Digital Alliance. The BELLA II project must contribute to the planting of seeds needed for the blossoming and growth of initiative fostering socioeconomic development. These will require public innovations and private innovations based on the principles of human-centered digital transformation. It will also call for envisioning creative spaces like testbeds and living labs to support skills development and demonstration of the potentialities of the ***Industry 4.0*** in particular, and of the ***cyber-physical systems revolution*** in general.

The open strategic dialogues process will provide the themes and the space where the stakeholders, policymakers, entrepreneurs, investors, researchers, connectivity providers, and ICT customers, will work together to identify, develop, and implement the solutions making possible the achievement of the specific objectives listed above. The meaningful connectivity will be a key driver of the strategic dialogues. The search and development of meaningfulness is, in this context, a socially constructed process. It represents, in other words, an intense social translation process facilitated with the intention of fostering collaboration, experimentation, and learning, where innovative stakeholders could test and refine their ideas, access funding and resources, and connect with potential partners and customers.

IV.2. The relationships between digital ecosystem, innovation, and socioeconomic development within the BELLA II project

When dealing with digital ecosystems and innovation we will consider two of the world approaches: that of USA and the European. The former is exemplified by what is known as the keystone advantage (Iansity and Levine, 2004) which grew out of Silicon Valley and has Google, Amazon, Apple, and Microsoft as some of its most distinguished representatives. In this case, we encounter an enterprise providing strong leadership regarding the design and construction of a digital space where a network of firms, customers, suppliers, and other stakeholders work together to create and deliver digital products and services. Such leadership is facilitated by the building of very large digital platforms providing the technological infrastructure that enables business and innovation interactions to occur.

In the USA model, in agreement with the strong entrepreneurial culture of their citizens and its highly competitive economy, there is limited intervention of the government. Approximately, 68% of the investment in science, technology, and innovation comes out of the enterprises. The support of the government (around 22%) covers mainly, education, research in the frontiers of science and technology, and large infrastructural development.

In the case of Europe, the starting conditions were different. A network of 28 countries characterized by a handful of them that were competitive in the global markets and the rest grouped into fast followers, learners, and laggards. As a whole, there were, approximately, 90% of small and mid-size enterprises and a pan-European innovation system characterized by markets, systemic and infrastructural failure. Such a situation could only be overcome by the

design and implementation of public policies capable of providing solutions to the failures detected.

Through three decades, the European Union has been involved in the design, implementation, and evaluation of public policies to support business and innovation ecosystems, as well as to promote socioeconomic growth. Significant progress has been made in an effort that started from a lineal public policy approach in the fifties, continued with the non-linear systemic model proposed by Freeman and Lundvall in the nineties, evolved into initiatives like RIS3, Horizon 2020, Horizon Europe in this century, and will expand into the mission-oriented public policies model proposed by Mazzucato.

In the case of USA, the large ICT platform developed has produced a highly competitive digital economy led by multinational corporations. In the case of Europe, the emphasis has been on the creation of publicly enhanced, digital ecosystems capable of supporting the large number of SMEs whose growth is essential for the social, economic, and technological development of the European Union.

Because of the strong public policy enforcement of the European case, we can say that the digital ecosystems being built in Europe has a broader scope. On one hand, they favour the growth of the digital economy with initiatives like the Digital Innovation Hubs; and, on the other hand, they attempt to foster the applications of the digital ecosystem to foster innovation in all European industrial value chains.

From the perspective of the specific's objectives 2 and 3 of the BELLA II project both scopes are relevant. We have already described the case of the DIHs. It is paramount for the BELLA II project, however, to contribute to public and private innovations enhanced by the application of digital transformation technologies. Such contribution should include not only the infrastructure for the testing and demonstration of the potentialities of digital transformation technologies to promote socioeconomic development but also the pilot project initiatives for the testing of the ideas generated by stakeholders during the open strategic dialogue process.

It must be clear that a digital ecosystem to support innovation is a broader concept that encompasses not only the development and diffusion of digital innovations but also the support and promotion of various forms of innovation across different public and private domains.

Within that broader concept, the notion of a digital ecosystem to support innovations constitutes, from the point of view of social systems theory, a significant increase in complexity produced by the greater diversity of actors, organizations, and institutions that interact and collaborate to drive innovation, digitalization, and growth in different industrial value chains. To sum things up, this broader notion encompasses all the digital technologies, infrastructure, resources, and human capital necessary to create, test, and scale new digital products, services, and business models.

Considering the above, it can be inferred that a digital ecosystem constitutes a subset of the solutions created using digital transformation technologies to support socioeconomic development. Specifically, solutions related to the digital economy. The digital ecosystem to support innovations will represent the whole set.

The conduction and execution of the strategic dialogue process will involve the generation of ideas and solutions regarding both, the digital ecosystem to support the digital economy, and the digital ecosystem to support innovation across all human activities. The core definition of RedCLARA digital ecosystem will be that given in section VI of this White Book. The main motivation for the work to be done will be the coproduction of value and the cocreation of innovations. The major critical success factors to be explored and dealt with are:

1. ***Policy support***: Policymakers play a critical role in creating an enabling environment for innovation. The examples of the Digital Innovation Hubs, in this regard, demonstrate the efficiency and effectiveness of digital ecosystems as infrastructures created from a strategic vision, by the European Union, of the role of digital transformation technologies in the emergent knowledge economy.
2. ***Cooperation and Collaboration***: The functioning and operation of digital ecosystems to support Innovation thrive on cooperation and collaboration among diverse actors. In this sense, the digital ecosystem constitutes the platforms where people, communities and organizations share data, information, knowledge, resources, and ideas.
3. ***Access to funding***: All worldwide experiences devoted to fostering digital ecosystems to promote innovations have required large investments in education, training, and research and development. The OSD processes must provide the space for the exploration, experimentation, and development of innovative funding schemes to produce the desired socioeconomic transformations.
4. ***Human-centered digital transformation***: The full exploitation of the benefits resulting from the application of digital transformation technologies could only be achieved by training the human capital needed to produce the desired societal changes. Such training represents a change of paradigm as it implies the abandoning of the capital-centered approach.
5. ***Infrastructure for connectivity***: The digital platform created to develop the digital ecosystem needs to provide the digital infrastructure required for the interactions among all stakeholders who will be engaged in the execution of the BELLA II project. Namely, high-speed internet, cloud computing, high-calculus capacity, and data storage.
6. ***Smart networked organizations***: Within a digital ecosystem, the smart networked organization, communities, customers, suppliers, and other stakeholders are connected through a digital network that enables real-time data sharing, knowledge management, remote work, and decentralized decision-making. This allows for more agile and adaptive responses to market changes, customer needs, and other factors that affect business operations.
7. ***Open Innovation***: Process needed within the digital ecosystem to support innovations through the creation of a space for the practice of leveraging internal and external ideas,

knowledge, technologies, and resources to drive innovation and create value for all persons, communities, and organizations involved.

IV.3. Different modalities of innovations to be developed by the stakeholders involved in the execution of the BELLA II Project

The interactions among the stakeholders acting upon systems or ecosystems of innovation are characterized by intense flows of ideas, knowledge, and technologies that are applied to promote socioeconomic development. Within the innovation ecosystem, each agent produces, coproduces and exchanges value in the form of innovations. In the Table shown below, we describe some of the innovations that must be developed during the execution of BELLA II and the stakeholders involved in their generation.

Typologies of Innovations and Stakeholders		
Innovation Type	***Definitions***	***Associated Stakeholders***
Public Innovations	Public innovation refers to the development and implementation of new public policies, processes, products, or services by government organizations or innovation agencies to address societal challenges, improve public services, and dynamize national and regional innovation ecosystems.	Ministries of Science and Technology, and National or Regional Innovation Agencies.
Educational Innovations	Educational innovations refer to the introduction of new methods, practices, technologies, or approaches that improve teaching and learning outcomes. These innovations may be focused on improving student engagement, increasing academic achievement, or enhancing the overall quality of education.	NRENs, Universities and Research Centres.
Digital Innovations	Digital innovation can be defined as the development and implementation of new or improved products, services, processes, or business models that leverage digital technologies. Digital innovation involves the application of technologies such as artificial intelligence, cloud computing, big data analytics, and the Internet of Things (IoT) to create new value propositions for customers or to improve operational efficiency.	RedCLARA, NRENs and Research Centres.
Digital Marketing Innovations	The application of social and digital transformation technologies to the processes of coproduction of value and cocreation of innovations by stakeholders acting within a digital ecosystem.	RedCLARA and NRENs

Social Innovations	Social Innovation can be defined as the management of a network made up of a diversity of social, political, economic, and technological agents, who interact with the purpose of generating solutions capable of producing significant changes in the patterns of thought and action of society.	Ministries of Science and Technology, and National or Regional Innovation Agencies. RedCLARA. NRENs.
Organizational Innovations	Organizational innovation refers to the process of introducing new ideas or changes to an organization's structure, culture, processes, products, or services with the purpose of improving its performance, competitiveness, or relevance. It involves the development and implementation of new methods, systems, and practices to enhance organizational efficiency, effectiveness, and adaptability to changing environments.	RedCLARA and NRENs.
Innovations in Social systems Design	Innovation in social systems design refers to the development and implementation of new and improved ways of organizing and delivering social services and interventions. It involves the creation of novel solutions to address complex social issues and challenges, such as poverty, inequality, and social exclusion.	RedCLARA, NRENs and Ministries of science and Technology.

It is likely that the stakeholders could identify, during the conduction of the open strategic dialogues, additional forms of innovation. For example, financial innovations to secure the funding required by some of the innovations conceived, and innovations intensive in knowledge and technologies to meet the challenges of inclusive human centered digital transformation.

IV.4. Summary of Digital Ecosystems relevant initiatives worldwide

At the beginning of this century, the exponential and extraordinary changes that were taking place in information and Communication Technologies led to a situation characterized by:

- Obsolete legacy systems were unable to cope with the challenges produced by the new dimensions of the Internet.
- Scarcity of professionals with the digital skills required to operate in the knowledge economy.
- Insufficient connectivity to support the broadband network and data centres needed to foster socioeconomic development.
- A need to invest, significantly, in the development of the new ICT infrastructure needed to overcome the emergent challenges.
- A need to develop knowledge, technology, and innovations to meet the challenges of the digital and knowledge economy.

Two decades later, the pace of the ICT evolution has accelerated, and the challenges are even greater. We have gone from client-server infrastructures to digital ecosystems and are witnessing the advent of Industry 4.0, as well as the emergence of the cyber-physical systems revolution. The advanced nations, searching for solutions to stay ahead of the pack, are launching innovative policies and implementing highly ambitious programs to develop the new capabilities needed. Because of this, we encounter today, a great variety of programs conducted worldwide with the aim of developing a digital ecosystem to support the digital economy, as well as innovation in all industrial value chains. In the exhibit below we present some of the initiatives, that are considered references or benchmarks in the international arena.

The **Digital Technology Supercluster** is a Canadian government-funded initiative aimed at promoting collaboration between companies, research institutions, and other organizations in the technology sector to drive innovation and economic growth. The Digital Technology Supercluster is focused on investing in and promoting digital technologies such as artificial intelligence, quantum computing, and advanced data analytics to develop new products and services, improve productivity, and create new jobs. The initiative is designed to provide funding, resources, and support to help organizations develop new ideas and turn them into successful commercial ventures. The Digital Technology Supercluster is one of five superclusters that are part of Canada's Innovation Superclusters Initiative, which aims to drive economic growth and innovation across the country.

The **Digital Silk Road Program** is a strategic initiative launched by China to promote digital connectivity and cooperation between China and countries along the historical Silk Road economic belt. The program aims to enhance regional digital infrastructure, promote digital trade and investment, and foster the development of the digital economy in the region. It encompasses a range of initiatives and projects, including the construction of digital infrastructure, the development of digital trade and e-commerce platforms, the promotion of cross-border data flows, and the sharing of digital technology and expertise. The program is seen as a key element of China's broader Belt and Road Initiative, which seeks to promote economic integration and cooperation between China and countries in Asia, Europe, and Africa.

The **Society 5.0** is a Japanese government initiative that aims to create a new society that balances economic advancement with social issues, including aging populations and environmental sustainability, using digital technologies. The concept of Society 5.0 was first introduced in 2016 as part of Japan's "Fifth Science and Technology Basic Plan" and is seen as the next step in human social development after the hunting society (Society 1.0), agricultural society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0). Society 5.0 envisions the integration of cyber and physical systems (CPS) to create a human-centered society that delivers solutions to complex societal issues, such

as healthcare, transportation, and disaster management, and provides new business opportunities for companies.

The **Digital Catapult** is a leading UK technology innovation centre that aims to accelerate the development and adoption of advanced digital technologies across the economy. It was established in 2013 with funding from the UK Government's Technology Strategy Board and operates as an independent non-profit organization. The Digital Catapult works with businesses, universities, and government agencies to support innovation, promote collaboration, and help companies bring new digital products and services to market. It offers a range of programs and services, including access to funding, expertise, and cutting-edge facilities and equipment.

In South Korea, the government has implemented several programs to support digital innovation ecosystems, including the **Creative Economy Innovation Centers** and the **Global ICT Innovation Program**. These programs provide funding and support to startups and small and medium-sized enterprises (SMEs) working on innovative digital solutions.

The **Silicon Valley Innovation Program** (SVIP) in the US: This program seeks to connect government organizations with innovative technology startups to solve complex problems and improve public services.

The **Smart Nation** initiative in Singapore: This program seeks to leverage technology and innovation to improve the quality of life for citizens and drive economic growth.

Latin America and the Caribbean are lagging in all fronts. It is not only that the available infrastructure is obsolete, but also that there is no strategic vision of what the countries need to do to meet the evolving challenges. The Digital Alliance EU-LAC represents a window of opportunity, and BELLA II is a space for the exploration, through the open strategic dialogues, of the innovative solutions that must be deployed to reduce the digital divide that hinders our incorporation into the knowledge and digital economy.

V. The stakeholders that will be involved in the design and building of the RedCLARA digital ecosystem

The ecosystems exist and survive if they can create and sustain the existence and sustainability of the species that populate them. Over the last two decades, the European Union, as shown earlier, has performed significant research regarding the conceptualization, building, and operation of Information and Communication Technologies systems capable of contributing to the competitiveness, productivity, and innovation capabilities of the nations that integrate it. The

concept of digital ecosystems is, undoubtedly, the major outcome of the theoretical and empirical work done thus far.

One of the main lessons learned from that effort is that it is important, throughout the process of design and building of DE, to maintain a user-centric approach, ensuring that the digital ecosystem addresses the needs and preferences of the target audience. In this regard, collaboration with stakeholders, iterative development, and continuous improvement are key principles for designing and building successful digital ecosystems.

Methodologically, the user-centered design is conceived as a participatory process, which emphasizes the importance of understanding users' mental models, expectations, and images throughout the design process. These approaches involve user research, prototyping, and iterative testing to ensure that the design aligns with users' mental models and addresses their needs.

In the case of the design and building of the RedCLARA digital ecosystem, we will draw from the practices that have been developed in Europe and other OCDE countries—contextualizing them to produce a tailor-made solution to the needs of stakeholders in LAC involved. By doing so, we will engage in a socio-technical and systemic approach to carry on the design and building of the RedCLARA DE.

The social dimension entices the process by which visions, ideals, ideas, values, and aspirations are shared, collectively agreed upon, and articulated by the ecosystem's stakeholders (Banathy, 1996). In this context, the stakeholders are organizations who serve the system, are served by it, and are affected by it. The stakeholders who will be involved in the design and building of the RedCLARA digital ecosystem are the ones listed and described below.

1. ***Connectivity providers:*** include the big telecommunication providers and the many small companies that own infrastructure and provide services to local communities. With them, we will explore and benchmark the technical, legal, and organizational solutions applied in other regions, for example, the use and sharing of dark fibre owned by electricity and other facilities companies, the connection to existing Internet Exchange Points (IXPs) to distribute the connectivity of the backbone to the final users, the use of other complementary technologies like WIFI 6, 5G or satellite, the deployment of sub fluvial cables and many others. Using this approach, we expect to guarantee that more end-users benefit from the investment contributing to increasing capillarity and coverage, which is essential to extend the benefits of the projects to a bigger population.
2. ***The Public Policy Makers***: these include the stakeholders that, at the national, local, and international levels, share the responsibilities of designing, implementing, and evaluating, in the transitional times of this century, the policy instruments and mechanisms leading to scientific and technological development, economic growth and social inclusion. Such policies must include the financial support needed for connectivity and fostering the

social innovation processes that are key for trust building, value coproduction, and cocreation of innovations.

3. ***National Research and Education Networks (NRENs) and National Research and Education Digital Ecosystem***: these include the networks that created RedCLARA, whose roles as lead users will be crucial in what relates to knowledge and innovation management and in the provision of the knowledge-intensive business services needed to overcome the digital divide between LAC, and the most advanced OECD countries.
4. ***Universities and Research Centres:*** these stakeholders will be key for the creation of new NRENs and the execution of research leading to the finding of solutions to the most pressing issues associated with research and education.
5. ***Multinational Organizations***: these include stakeholders like MERCOSUR, SICA, and the European Union whose roles as promoters of international collaboration, and good practices regarding ecosystem development will be a critical success factor for the execution of the BELLA II project.
6. ***Large, small, and medium-sized enterprises***: these include stakeholders from the private sector whose roles as financers, users and developers of innovation capabilities and business models will be crucial for the sustainability of the evolving RedCLARA DE.
7. ***Financial Organizations***: these include both, private and public funding stakeholders capable of providing monetary resources for the building of the needed infrastructure and the execution of strategic projects.

The technological dimension involves the exploration, experimentation, and development of cognitive artifacts, which are physical or digital tools that aid in cognitive processes. Digital ecosystems are composed of various technological components and systems that enable interactions, data exchange, and collaboration. By working with the breadth of digital technologies available, it will be possible to explore and select the appropriate tools, platforms, and infrastructures to support the ecosystem's objectives and functionalities.

Digital technologies offer unique capabilities that can be harnessed to enhance the functioning of a digital ecosystem. Designers can leverage these capabilities, such as data analytics, artificial intelligence, and cloud computing, to provide personalized experiences, enable efficient information processing, and facilitate seamless connectivity within the ecosystem.

From the perspective of the user-centered approach, we need to understand the diverse digital technologies used by ecosystem participants. This information is crucial for designing. We need to consider the devices, interfaces, and interaction patterns that users are familiar with and comfortable using. This ensures that the digital ecosystem's design aligns with users' mental models, making it intuitive, engaging, and easy to navigate.

Finally, it is important to consider the scalability and future readiness of the technological solutions to be applied. Designing digital ecosystems requires anticipating technological advancements and future needs. In that regard. It is necessary to consider the scalability and flexibility of the chosen digital technologies to accommodate growth, changing user

requirements, and emerging technologies. This ensures that the ecosystem can adapt and evolve over time while leveraging new technological capabilities.

In the language of social systems design, they speak of dialogical conversations. By this, they mean a process where organizations, institutions, communities and persons learn to think together or in a shared way, not only in the sense of analysing and seeking solutions to a common problem or creating new knowledge but also in the sense of occupying a shared sensitivity, where the resulting thoughts, emotions, and actions do not belong to an individual but to the team or the group (Bohm and Nicols, Belathy, Yankelovich, D. and Rosell, 2004).

In the case of RedCLARA, we speak of ***Open Strategic Dialogue (OSD)*** as the process allowing the creation of a space in which the ideas, emotions, expectations, knowledge, and new realities that have been revealed to the group serve as a springboard for the construction of a process of collective reflection, collective ideation, and collective generation of solutions thanks to the sharing of resources and capacities that stakeholders already possess, combined with those that must develop, to bring forth the transformative vision of the national research and educational networks.

Figure 2 represents, in a non-exhaustive manner, the stakeholders involved in the design and building of RedCLARA digital ecosystem and offers ideas about many of the processes that could take place because of the interactions and exchanges within the digital realm.

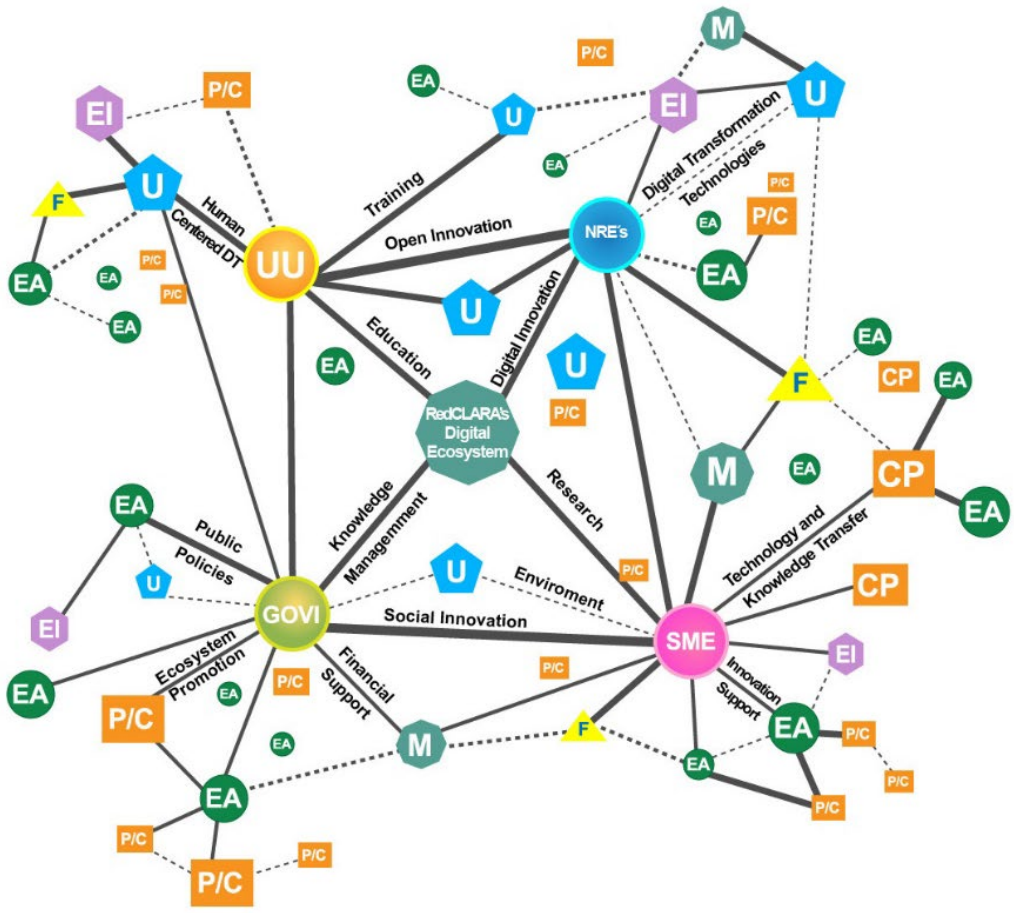

Figure 2: Image of RedCLARA digital ecosystem, depicting it as social and technological domain where all stakeholders share their resources, competences, and capabilities to generate the knowledge and technologies required to the finding of solutions to the challenges posited to socioeconomic development in the digital era.

As shown in Figure 2, there are many processes that will take place during the operation of the RedCLARA digital ecosystem. It belongs to the category of Purposeful/purpose-seeking systems defined by Banathy (1996). This implies that it is an ecosystem guided by a vision of the future that is constantly evolving and searching for new and innovative ways to adapt to the emergent environment and to the challenges of Industry 5.0.

During the conduction of the OSD process to design such type of ecosystem, the stakeholders must engage in the exploration of the three lenses suggested by Banathy. Namely: (i) the ***ecosystem-environment lens***, differentiating RedCLARA DE from its environment and other ecosystems within its environment; (ii) the ***function-structure lens,*** illustrating the activities to be performed and the artifacts to support them; and the ***process-behavioural lens***, indicating the manners by which the ecosystem transform inputs to outputs.

VI. The working definition of RedCLARA Digital Ecosystem and its implications

A working definition is often a starting point, a hypothesis, or a provisional understanding of a concept. Through further exploration, analysis, and validation, it can gradually evolve into a more precise, accurate, and comprehensive definition. As the concept becomes better understood and its distinctions are clarified, the working definition may be revised and refined to align with the consensus and established terminology within a specific field or community.

Based on our secondary research and the primary research activities undertaken in the execution of the BELLA II project thus far, we proposed the following working definition of the RedCLARA digital ecosystem.

> RedCLARA digital ecosystem will be an open, inclusive and gender-neutral socio-technical domain where stakeholders, acting as open social systems agents, will engage in the design and creation of a self-organizing digital infrastructure environment capable of supporting the functioning of a smart network of actors (individual, communities and organizations) engaged in processes of cooperation, knowledge sharing, innovation management and development of solutions to the socioeconomics challenges of LAC countries.

The working definition of the DE expresses the intentionality of RedCLARA concerning the design and building of a socio-technical domain that will become a sustainable space created because of the interactions occurring during the open strategic dialogue process. In this context, design, as proposed by Banathy in 1996, is a creative, decision-oriented, disciplined inquiry that aims to identify expectations, aspirations, and requirements of the ecosystem to be designed; clarify ideas and images of alternative representations of the future system; devise criteria by which to evaluate those alternatives; select and describe or "model" the most promising alternatives; and prepare a plan for the development of the selected model.

The proposed working definition of RedCLARA DE has several implications that must be considered during the OSD process. In the previous section, we have already described the notion of the ***socio-technical domain*** which indicates that RedCLARA DE intends to be a highly inclusive one, characterized by the interaction of (i) human agents operating from open social systems that work together to produce the political and economic conditions that make the DE possible and (ii) digital agents which include the connectivity, the hardware and software applications that provide the structure and the knowledge artifacts.

There is also the condition of ***self-organization*** which will lead to the spontaneous order of the open social systems reached through processes of random associations prompted by the coproduction of value, self-empowerment, self-sustainability, and self-development. The self-

coordination of these processes involves, in accordance with Boley and Chang (2007), interactions through mechanisms of swarm or collective intelligence.

The ***digital infrastructure environment*** alludes to a hybrid environment that contains human individuals, information services, network interaction, knowledge-sharing tools, and resources that help maintain synergy among the interacting open social systems.

The ***smart network of actors*** implies the utilization of swarm, human, and artificial intelligence to explore, experiment and develop value-driven solutions in order to take advantage of social and technological opportunities.

Finally, ***the processes of cooperation, knowledge sharing, innovation management and development of socioeconomics solutions to the challenges of LAC countries*** state the scope of the interactions occurring within the digital ecosystem and its environment to achieve the general and specific objectives of the BELLA II project.

In addition to the implications of the working definition of BELLA II digital ecosystem, there are, as shown in the exhibit below, features and properties of DE that have been proposed by Boley and Chang, (2007) that must be taken into consideration to fully understand digital ecosystem dynamics.

Species in an ecosystem are composed of autonomous agents or individuals. These autonomous agents participate in the community of their initiative.

Species and their agents are heterogeneous and encompass loosely coupled relationships within an ecosystem. Unlike traditional networked environments where entities or objects are carefully blended, the community encapsulates all individuals.

Species share commonly agreed vocabularies and communicate knowledge through commonly shared ontologies.

Species can be clients (need services) or servers (provide services) in a collaborative environment. In a traditional collaborative environment, they are either clients or servers, and their role is predefined.

Species come to an ecosystem of their demand. They are motivated by their benefit or profit. They remedy problems through collaborative effort, self-organizing, sub-tasking, coordinated actions, and sharing intelligence and skills. Unlike the traditional collaborative environment (such as client-server), which is a controlled environment, where entities or objects may not gain direct benefit or profit from the collaboration.

Digital species are human-designed intelligent software agents. They are designed to work together and communicate with each other.

Species provide an ecosystem with dynamism, efficiency, and stability and they are proactive, adaptive, and responsive.

Notice that Boley and Chang have fully adopted the natural ecosystem metaphor. In their work, there are human species and digital species. The former orchestrates and manages all the processes leading to the coproduction of value and cocreation of innovations, while the latter provides the knowledge creation and distribution artifacts needed to operate with digital transformation technologies.

In our proposed working definition, we use open social systems to emphasize both, the human-centered approach that we are following, and the fact that the complex dynamic nature of digital ecosystem operations, and interactions requires, for their success, a collaboration, platform-based exchanges facilitated by data-driven decision-making, and effective governance.

VII. The Image of RedCLARA human-centered, data driven Digital Ecosystem

In accordance with the general and specific objectives of the BELLA II project, the next four years will contribute significantly to: (i) the expansion and consolidation of the digital ecosystem to support EU-LAC alliances, and (ii) the increase in the application of digital transformation technologies to issues such as education and research, the promotion of knowledge management and knowledge sharing, and the co-creation of public and private innovations.

The accomplishment of such objectives will be facilitated by the designing and building of a complex digital ecosystem capable of involving the stakeholders described in the previous section, acting as open social systems, and sharing their resources, capabilities, and competencies to produce the desired outcomes. In other words, by engaging, under a common shared vision, a network of organizations, institutions, communities, and persons in the planning, execution, monitoring, and evaluation of the actions and activities needed to achieve the digital transformations desired. The first step in that regard will be the description, as it is shown in the following exhibit, of the roles to be played by the stakeholders populating the DE.

1. ***Digital provider role***: capable of ensuring the bandwidth and the storage space required to support the digital infrastructure that will allow the achievement of the general and specific objectives of the BELLA II project.
2. ***Data collection, analytics, and integration role***: Includes the storage as well as the use of data analytics techniques to extract insights, patterns, and trends from the collected data. For example, techniques as machine learning, artificial intelligence, and predictive modelling, that may be employed to uncover valuable insights and drive informed decision-making.
3. ***Articulator role***: actors capable of facilitating the processes by which the stakeholders engage in the activities of coproduction of value and cocreation of innovations within the DE.
4. ***Knowledge providers' role***: actors who provide digital innovations, and knowledge-intensive digital applications that could be used to support the combination, recombination, and generation of new services by lead user's stakeholders.
5. ***Broker role***: actors that specialize in the identification of business opportunities and the involvement of producers and consumers of services in the formulation and execution of innovative projects to take advantage of them.
6. ***Policy design and implementation role***: actors participating in the design and the implementation of public policy instruments aiming at reducing the digital divide between LAC and the more advanced nations.
7. ***Regulatory role***: actors responsible for conceiving and implementing the rules and regulations that determine what is possible within the digital ecosystem.
8. ***Financing role***: actor responsible for the generation and assignment of the funding of the policy instruments needed to achieve the objectives of the BELLA II project.

During the execution of the OSD process, the involved stakeholders will play the roles listed above. To do so, they will engage in an intense communication process needed to define the functions associated with each role, the infrastructure needed to perform the role, the partners they will need to provide the function, the manner by which they will self-organize to achieve a particular purpose, the policies to be implemented in order to empower all stakeholders, and the financial strategies they will deploy to access the desired level of funding.

Within the digital ecosystem to be developed, a stakeholder could play more than one role as it interacts with human and artificial agents. In some instances, the actor could be a provider of knowledge, services, and innovations, while in others could be a consumer. Throughout the process, it's important to maintain a user-centric approach, ensuring that the digital ecosystem addresses the needs and preferences of the target audience. Collaboration with stakeholders, iterative development, and continuous improvement are key principles for designing and building successful digital ecosystems.

In this section, we intend to present an image of the ***human-centered, data-driven, RedCLARA Digital Ecosystem***. To achieve such purpose, we will work with the concepts of the "image" or "image of the future," developed by Kenneth Boulding in his book ***"The Image: Knowledge in Life and Society"*** written in 1956. Boulding defined the image as an individual or collective mental representation of the future. He argued that our actions and behaviours are guided by the image we hold of the future, rather than just being driven by present needs or desires. The image serves as a motivating force that shapes our aspirations, goals, and decision-making processes.

The application of the image concept will provide depth to the design thought process, as well as guidelines for the structuring of the open strategic dialogue process from a user-centric perspective that should involve:

1. ***Visioning Workshop***: A visioning workshop organized to engage the DE stakeholders in a facilitated dialog to collectively envision a desirable future for the EU-LAC Digital Alliance.
2. ***Co-creation and Iterative Design***: Involving work by the design team and relevant stakeholders with the outcomes of the visioning workshop, to develop a comprehensive implementation plan.
3. ***Narrative and Communication***: To develop a compelling narrative of the envisioned future of the RedCLARA digital ecosystem. Such narrative must be conveyed through visual materials, videos, and presentations that effectively communicate the image to community members, funders, and other relevant stakeholders. The narrative must highlight the potential benefits, showcases success stories from other similar initiatives, and generates enthusiasm for the BELLA II project.
4. ***Implementation and Evaluation***: Regularly monitor and evaluate the progress of RedCLARA ecosystem development against the image to assess its impact and identify areas for improvement. By measuring key indicators and outcomes, stakeholders can gauge the extent to which the digital ecosystem is aligning with the desired image and make informed decisions for further refinement and optimization.

5. ***Stakeholder Empowerment***: Throughout the OSD process, stakeholders will be actively engaged and empowered to contribute to the implementation and maintenance of the RedCLARA digital ecosystem. Involving stakeholders in decision-making processes, volunteer initiatives, and skills development programs, will contribute to fostering a sense of ownership and collective responsibility for the success of the initiative.

By following the above-described guidelines, we will ensure that the user-centric digital ecosystems design will be driven by a shared vision. A vision that reflects the needs and aspirations of the stakeholders, and communicates, effectively, the desired future state, and allows for ongoing learning and adaptation.

In summary, we will be dealing with a hybrid digital and physical communicational space where human agents ascribed to the open social systems and digital agents capable of storing and processing large amounts of data will interact to produce information and knowledge that could be applied along the stages of the BELLA II project execution. The human agents will provide the overall strategic vision associated with the project, as well as the management of the processes for the coproduction of value and the cocreation of innovations.

The digital agents, through artificial intelligence, machine learning, and digital innovations will provide support for the generation, combination, recombination, and emergence of new solutions fostered by the communications and interactions between stakeholders playing the roles described.

The final image of the RedCLARA digital ecosystem will evolve as a result of the interactions described in the work packages conceived for the execution of the BELLA II project. At the present time, we will provide a working image of the RedCLARA human-centered, data-driven digital ecosystem with the intention of giving an idea of the issues and challenges involved. Figure 3 illustrates such a working image.

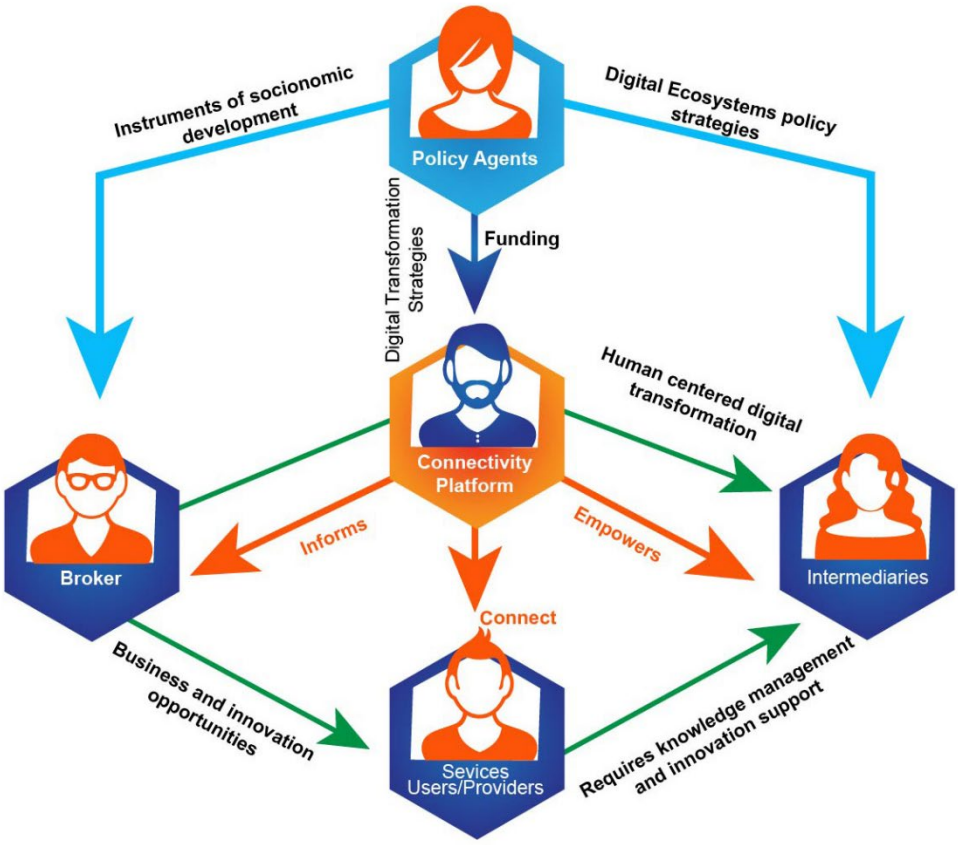

Figure 3: RedCLARA Digital ecosystems will bring together diverse technologies, such as IoT devices, cloud computing, data analytics, artificial intelligence, and more, into a unified ecosystem. This integration enables the exchange of data, interoperability, and collaboration among different technological components, creating a cohesive digital infrastructure within the hybrid space.

The figure portrays a rather complex digital and physical space where policymakers, brokers, connectivity providers enterprises, financial institutions, national networks of research and education, universities, and I+D+I organizations, interact in a systemic, non-linear way, to fulfil the general and specific objectives of the BELLA II project.

RedCLARA digital ecosystems will function as the backbone platform of the aforementioned digital and physical space, enabling seamless integration, collaboration, value creation, and innovation within the broader social system. To that purpose, RedCLARA DE will bring together diverse technologies, such as IoT devices, cloud computing, data analytics, artificial intelligence, and more, into a unified ecosystem. Such integration will enable the exchange of data, interoperability, and collaboration among different technological components, creating a cohesive digital infrastructure within the hybrid space.

The centre of the working image shows the connectivity platform, the main objective of the BELLA II project which will consume approximately 80% of the allocated funding. There are two principal functions to be fulfilled by the evolving RedCLARA digital platform. The first one is the

connectivity needed to grant access to a high-quality Intranet to all LAC countries participating in the BELLA II project and beyond. The second function is related to the provision of the space where all stakeholders will interact to coproduce value and co-create innovations. In other words, the interactions, and exchanges between stakeholders to identify, access and employ resources, competencies, and additional sources of funding which could contribute to the enhancement of the impact of the political, scientifical, technological, and economical solutions that BELLA II project will help to solve.

The other two drivers of the digital and physical space are the ***human-centered digital transformation*** and the ***data-driven strategy***. The former refers to the process of leveraging digital technologies and strategies to enhance and optimize human experiences, capabilities, and interactions within an organization or society. It emphasizes placing human needs, values, and aspirations at the core of technological advancements and digital initiatives. The goal is to create meaningful and effective digital solutions that align with human expectations, behaviours, and goals.

In a human-centered digital transformation, technology is not seen as the sole focus but rather as an enabler that empowers individuals, improves their well-being, and enhances their ability to solve problems and achieve their objectives. It involves considering the social, cultural, and psychological aspects of people while designing and implementing digital solutions. In the case of RedCLARA the applications of the principles and practices of HCDT will contribute to:

- ***User Experience Enhancement***: Human-centered digital transformation focuses on improving the overall user experience within the ecosystem. By leveraging data insights about user preferences, behaviours, and strategic issues, the ecosystem can tailor and optimize user interactions, interfaces, and personalized recommendations, resulting in enhanced satisfaction and engagement.
- ***Ethical and Responsible Data Usage***: Human-centered digital transformation emphasizes ethical and responsible data usage within the ecosystem. It considers user privacy, consent, and data protection regulations to build trust with users. Transparent data practices and user control mechanisms are implemented to ensure that users have a clear understanding of how their data is being used.
- ***User Empowerment and Engagement***: Human-centered digital transformation seeks to empower users within the ecosystem. It provides opportunities for user participation, co-creation, and feedback, allowing users to actively engage and contribute to the ecosystem's development. User empowerment enhances the sense of ownership and fosters a collaborative relationship between users and the ecosystem.
- ***Inclusive and Accessible Design***: Human-centered digital transformation aims to create inclusive and accessible digital experiences within the ecosystem. It considers diverse user needs, abilities, and contexts to ensure that the ecosystem is accessible to all users, including those with disabilities or limited digital literacy. This promotes equal participation and avoids excluding any user segment.

- ***Continuous Learning and Improvement***: Human-centered digital transformation fosters a culture of continuous learning and improvement within the ecosystem. It encourages user feedback, data-driven insights, and iterative design cycles to drive ongoing enhancements, feature updates, and innovation based on user needs and changing market dynamics.

The second driver is crucial for the success of the RedCLARA digital ecosystem. During the execution of the BELLA II project, data will play a key role in supporting and fostering the interactions and in determining the outcomes of the process of coproduction of value and cocreation of innovations within the DE. The architecture or structure of a data-driven digital ecosystem will provide the underlying framework, components, and services that enable the collection, processing, analysis, and utilization of data within the ecosystem.

During the conduction of the strategic dialogue process promoted by BELLA II, significant effort must be made to generate the architecture of a data-driven digital ecosystem. Among the key aspects to consider are:

1. ***Data Sources***: Identify and integrate various data sources within the ecosystem, such as user-generated data, operational data, external data feeds, or IoT sensor data. These sources may include structured, semi-structured, or unstructured data.
2. ***Data Collection and Integration***: Implement mechanisms to collect and integrate data from different sources. This could involve APIs, data connectors, or data ingestion pipelines to gather data and consolidate it in a central repository or data lake.
3. ***Data Storage and Management***: Establish data storage and management infrastructure that can handle large volumes of data. This may include distributed databases, data warehouses, or cloud-based storage solutions. Ensure appropriate data governance, security, and privacy measures are in place.
4. ***Data Processing and Analytics***: Implement data processing and analytics capabilities to transform raw data into meaningful insights. This may involve batch processing, real-time streaming, or in-memory analytics to derive valuable information from the data.
5. ***Machine Learning and AI***: Incorporate machine learning and artificial intelligence techniques to analyse data, discover patterns, make predictions, and generate actionable insights. This can involve building and training models for recommendation systems, predictive analytics, or anomaly detection.
6. ***Visualization and Reporting***: Develop visualization tools and reporting dashboards to present data insights in a meaningful and intuitive manner. This allows stakeholders to easily understand and interpret data and make informed decisions.
7. ***Data Sharing and Collaboration***: Enable data sharing and collaboration among ecosystem participants while ensuring data privacy and security. This may involve establishing data-sharing agreements, implementing data access controls, or using federated learning approaches.

8. ***Continuous Improvement and Adaptability***: Design the architecture with scalability, flexibility, and adaptability in mind. The ecosystem should be able to handle evolving data requirements, changing business needs, and emerging technologies.

By taking these aspects into account, RedCLARA will be able to design and build a robust data-driven digital ecosystem that leverages data effectively to drive insights, innovation, and value creation. It is important to adapt the process to the specific needs and context of the ecosystem being developed.

VIII. Identification and selection of architectural requirements concerning the development of the BELLA II digital ecosystem

The architecture or structure of RedCLARA´s human-centered, data-driven digital ecosystem refers to the underlying framework, components, and services that enable the collection, processing, analysis, and utilization of data within the ecosystem, as well as to the facilitation of the coproduction of value and cocreation of innovation processes. Based on the secondary research done during the preparation of the BELLA II proposal, we adopted, as shown in Figure 4, a multilayered architecture like the one proposed and developed in the European project DBE and OPAALS previously cited.

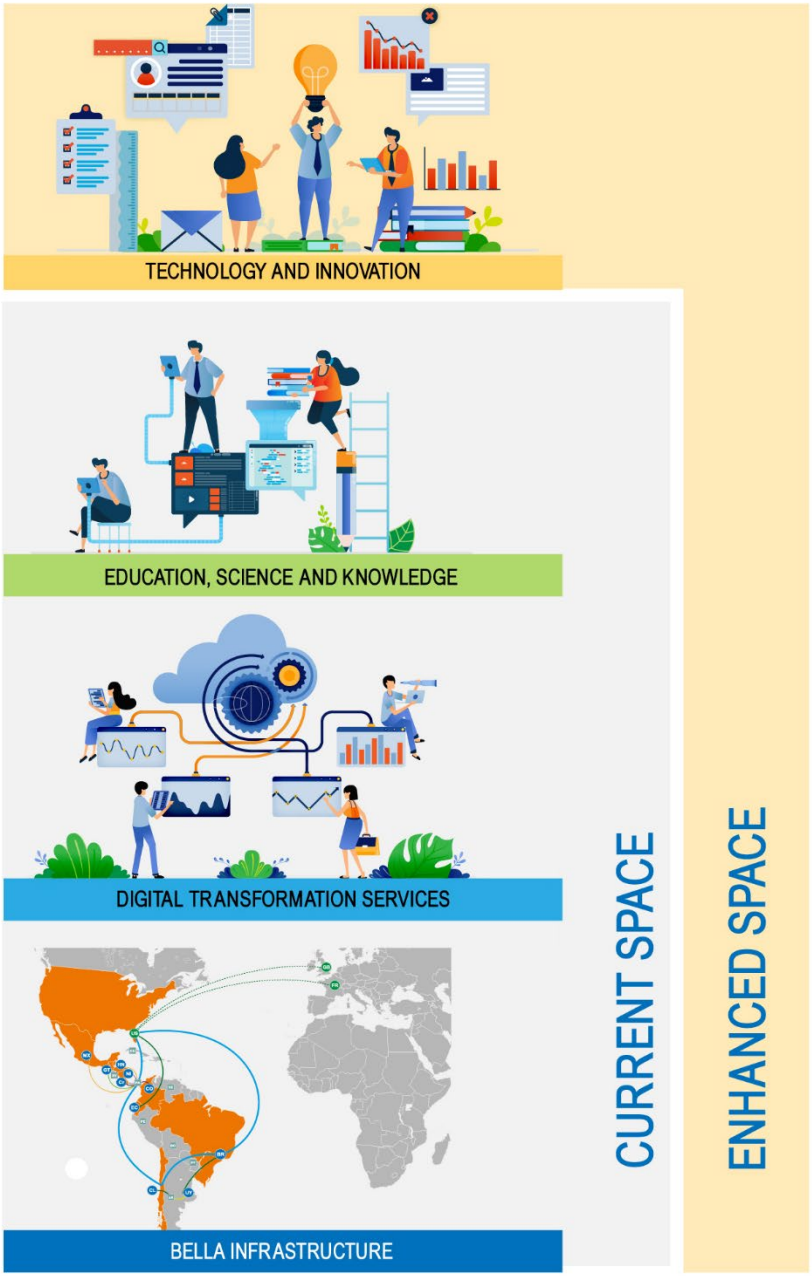

Figure 4: The multilayered architecture that will be adopted by RedCLARA human-centered data-driven digital ecosystem in order to ensure the appropriate functioning of the connectivity as well as to support skill development, knowledge and innovation management, and value coproduction.

Each one of the layers shown represents a domain or a space with specific functions where the various social systems formed by the DE stakeholders interact to generate knowledge, technologies and innovations that contribute to the achievement of the level of development and well-being that a region, a country or a community of countries wishes to attain. The functions to be provided by these domains are described below.

1. **Infrastructure and Enabling Technologies Domain:** This layer contains the infrastructure created by BELLA-T Phase 1, and will contain BELLA II connectivity, with the purpose of contributing to the development of the digital infrastructure capable of supporting the academic, business, and public activities associated with the processes of generation, dissemination, and application of knowledge. This domain comprises high-capacity connectivity networks, high-performance computing centres, data centres, blockchain platforms, sensors, artificial intelligence, research infrastructures, laboratories, universities, wireless connection networks (5G and Wi-Fi 6), innovation hubs and technology centres.
2. **Digital Services Domain:** This layer includes the wide variety of services generated upon the foundation provided by the digital connectivity infrastructure built by RedCLARA to provide, in conjunction with European NREN and other stakeholders, applications services, digital innovations, and technical training, to enhance the depth and the impact of the R&D work done in LAC.
3. **Education, Sciences, and Knowledge Domain:** This layer is where the National Research and Education Networks that have created RedCLARA will participate in internal and external projects leading to knowledge generation and management processes which produce resources, capacities, and competencies in strategic areas related to the mission of NREN as providers of innovations in research and education.
4. **Technology and Innovation Domain:** This layer will be the space for collaboration with initiatives such as EU-LAC Digital Alliances for socioeconomic development, and BID Lab in the design, development, and implementation of the innovations in digital technology that will consolidate RedCLARA, in the midterm, as a testbed and Digital Hub for the exploration, experimentation, and development of solutions contributing to the reduction of the digital divide that separates our countries from more advanced nations.

The requirement associated with the building of such four layers of architecture will be:

I. A strong information infrastructure that extends beyond traditional human reach or the original closed individual organization.

II. An interactive community that directs similar species to a domain-oriented cluster.

III. A rich data and information resource that offers cost-effective and value-added customer or agent services.

IV. A new form of electronic interaction, provision of digital services and use of services.

V. A high connectivity and electronic handling of information of all sorts.

VI. A smart information use through capturing business intelligence from the web.

VII. A platform for integration of businesses, governments, human endeavours, and advanced information systems.

VIII. An environment for cross fertilization and nourishing each other and supporting different needs within the digital ecosystem and between different digital ecosystems.

IX. A cross-disciplinary interaction and engagement for productivity, prosperity, and growth.

X. An underlying knowledge base through ontologies to support information communication that enables shared understanding of concepts.

XI. Provision of self-organizing, well-prepared, self-survival, self-coordination aimed at creating a sustainable environment for networked organizations or agents.

IX. The roadmap for the process of designing and building of RedCLARA's Digital Ecosystem

The ***roadmap for the process of designing and building of RedCLARA's digital ecosystem*** will evolve through the four years of project execution. During the execution of the BELLA II project, the roadmap for the evolutionary building of the RedCLARA digital ecosystem will face three challenges: (1) how to bring forth the intentions expressed by all stakeholders into an evolutionary image of the DE to be designed and build together; (2) how to transform the

envisioned image of the DE into functional designs of the socio-technical ecosystems to be built; and (3) how to develop societal/organizational arrangements that implement and maintain the design of the evolutionary roadmap of RedCLARA DE. The phases associated to the execution of the project are those shown in Figure 5.

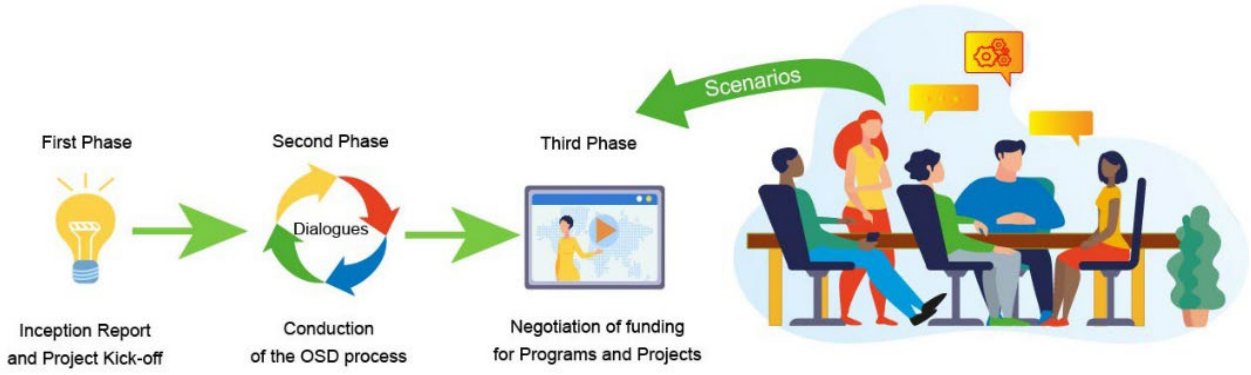

Figure 5: Phases to be covered during the execution of the BELLA II project.

The search for solutions by RedCLARA to the challenges mentioned above will lead, thanks to the proposed methodology of open strategic dialogues, to the establishment and creation of neutral consortiums, including, among others, the national research and education networks, universities, research centres, telecommunication operators, infrastructure owners, investors, development banks, public national institutions, regional agencies, international organizations, and communities.

The first and second phases will take place within the first year of project execution. The first phase will entice the project Kick-off meeting, the preparation of the inception report, the diffusion of the objectives of the project to a wider audience, and the generation of the documents to support primary research activities. Namely, surveys, webinars, scripts for the conduction of semi-structured interviews, and workshops.

The second phase will be dedicated to the conduction of the open strategus dialogue process. This will involve (i) the exploration of the dialogical spaces needed to identify the intellectual, digital, physical, and monetary resources required by the stakeholders to engage in the coproduction of value and the cocreation of innovations within the DE, (ii) the drafting of the terms of references for the bid concerning the provision of the connectivity services to be provided by specialized firms, and (iii) the processes of agreeing in the elaboration of a project portfolio, and the definition of the strategies and the management of the resources to achieve the desired objectives.

Finally, the third phase will involve the negotiation of the connectivity contract, as well as the formulation of the projects agreed upon by stakeholders, and the deployment of the financial

strategies required to secure access to the funds needed. The keystones associated with this phase are:

1. The generation of the project portfolio covering all areas of interest and of strategic value to participant stakeholders.

1. The execution of the contractual agreement granting the expansion of the connectivity to the LAC countries was agreed upon.

1. The implementation of the digital infrastructure is needed to support data generation, management, distribution, and innovation.

1. The building of RedCLARA human-centered data-driven digital ecosystem to foster knowledge and innovation management, coproduction of value, and cocreation of innovation within DE stakeholders.

1. The writing of the final report concerning the results, outcomes, and impacts achieved thanks to the execution of the BELLA II project.

X. The Governance of human-centered, data driven RedCLARA Digital Ecosystem

The definition of the governance of RedCLARA´s digital ecosystem to be agreed upon during the conduction of the open strategic dialog process should lead to: (i) the internal rules of coordination and relationship between stakeholders sharing the responsibility of achieving the general and specific objectives of BELLA II; (ii) the agreements concerning the meta-national, national, and regional strategies to be deployed by institutions, business associations, universities, civil organizations, and other interested agents to secure the resources needed for project execution, and (iii) the engagement of stakeholders in the participatory processes of co-production of value, and cocreation of innovations supported by the design and implementation **of public policies and private initiatives** aimed at fostering socioeconomic development in LAC.

The agreed definition of DE governance for the BELLA II project will be based on the recognition that the sustainability and growth of the digital ecosystem in the mid and long-term will require a sense of direction that is only possible to the extent that a consensus is reached and maintained among the stakeholders that share the responsibility of applying of digital transformation technologies to the finding of solutions to the problems identified. Such governance involves the interactions among stakeholders operating from the three levels (***Macro, Meso, and Micro***) shown in Figure 6.

Figure 6: The governance of RedCLARA DE involves establishing rules, policies, and structures that guide the interactions, behaviours, and decision-making within the digital ecosystem that makes possible the social and economic transformation desired.

The levels shown in Figure 6 are interrelated and interconnected. At the macro level, we find the governance activities encompassing the broader ecosystem as a whole and involving high-level policies, regulations, and frameworks that shape the overall governance structure. The meso-level governance ensures the planning, and implementation of the macro strategies needed for the envisioned reality to come through. Finally, the micro level focuses on managing the

operations, interactions, and responsibilities of individual stakeholders within the ecosystem. It includes aspects such as data governance, privacy policies, security measures, project executions, and compliance with ethical guidelines.

The open strategic dialogue process will provide the communicational space for the interactions between key stakeholders (government officials, businesses representatives, and the academic world) and will contribute significantly to the alignment with the ecosystem's purpose, values, and objectives, while also considering the unique characteristics and requirements of the digital age. At the end, the governance will be structured by taking into consideration organizational strategies, and operational architecture.

Organizational strategies

Among the key tasks to be performed regarding this issue are the leadership and governance structure of the digital ecosystem. This may include the appointment of a governing body, consortium, or steering committee responsible for overseeing the ecosystem's strategic direction, decision-making, and coordination among ecosystem participants.

The organizational architecture necessary to exercise the governance of the BELLA II project must promote the participation of institutions and organizations that ensure the continuity of the actions required for it to carry out its mission and fulfil the strategic vision that motivated its creators. Such architecture, as shown in a preliminary manner in Figure 7, illustrate the organizational instances that could emerge during the execution of the OSD process.

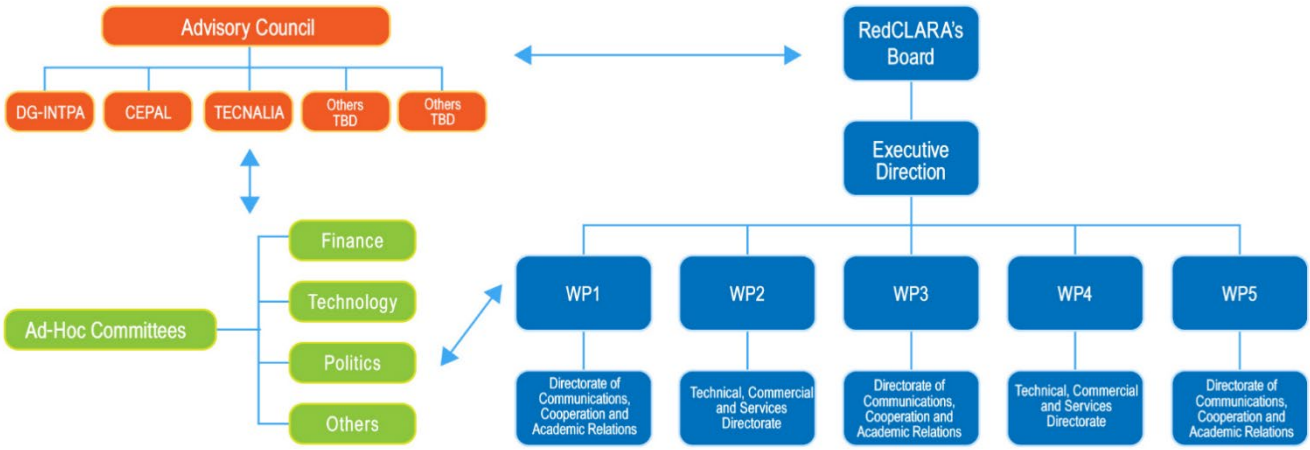

Figure 7.

Figure 7 implies the structuring of a governance in which representatives of the triple helix, and other stakeholders that are part of the BELLA II DE, are involved, from its beginning, in creating the conditions for its sustainable development. Note that the suggested governance proposal entices the strong interactions of:

1. A collegiate body represented by leaders of the triple helix, acting as creators of the strategic vision and orientation of the BELLA II digital ecosystem. This body would meet at least twice a year and on those special occasions when the situation warrants it.

1. RedCLARA, playing a key role as negotiator of the additional resources needed to achieve the desired levels of connectivity, and providing the autonomous management, and the self-organization of stakeholders to respond with flexibility and agility to the search for answers to the needs of the DE agents.

1. The Executive Directorate, responsible for coordinating the processes from which the science, technology, and knowledge needed for the fulfilment of BELLA II objectives is generated, disseminated, and applied through the DE.

1. The Operational Dimension needed to produce, at the micro level, the value and the innovations ensuring the sustainability of the DE in the mid and long term.

The organizational strategies must provide, besides the strategic vision, clear rules, policies, and guidelines that govern the operation and behaviour of ecosystem participants. This includes data sharing and usage policies, privacy and security protocols, intellectual property rights, and dispute resolution mechanisms. Ensure alignment with relevant legal and regulatory frameworks. All these elements are necessary to exercise a governance of RedCLARA DE capable of promoting the participation of institutions and organizations that ensure the continuity of the actions required to carry out its mission and fulfil the strategic vision that motivated its creators.

Operational architecture

The design of the operational aspects should be aligned with the goals, values, and objectives of the digital ecosystem. It should foster collaboration, efficiency, and value creation among ecosystem participants while ensuring a seamless and user-centric experience. These processes must be built on four pillars: **freedom of expression and communication; universal access to data, information, and knowledge; respect for cultural and linguistic diversity; and innovative research and educational policies.**

The key issues to be considered regarding this governance dimension are the ones briefly described below.

1. ***Digital Platform Infrastructure***: Develop a robust and scalable platform infrastructure that serves as the foundation for the digital connectivity. This includes designing and implementing the necessary hardware, software, and networking components to support seamless interactions, data exchange, and service delivery.
2. ***Interoperability and Integration***: Foster interoperability among different technologies, systems, and applications within the ecosystem. Define standards, protocols, and APIs to

enable seamless integration and data exchange between diverse ecosystem participants. This allows for efficient collaboration and resource sharing.

3. ***Data Management***: Establish data management practices to ensure the quality, security, and privacy of data within the ecosystem. Define data governance frameworks, data sharing policies, and data access controls. Implement mechanisms for data collection, storage, processing, and analytics to derive valuable insights and support decision-making.
4. ***Collaboration and Communication Channels***: Design communication channels and collaboration tools to facilitate effective communication and collaboration among ecosystem participants. This includes online platforms, chat systems, forums, and project management tools that enable real-time communication, document sharing, and task coordination.
5. ***Service Delivery and Value Exchange***: Define the mechanisms for service delivery and value exchange within the ecosystem. Establish guidelines and frameworks for pricing models, revenue sharing, and contractual agreements between providers and users. Ensure transparency and fairness in value creation and distribution.
6. ***Monitoring and Evaluation:*** Implement monitoring and evaluation mechanisms to track the performance and effectiveness of the operational aspects. Use metrics and analytics to measure key performance indicators, user satisfaction, and ecosystem health. Regularly review and assess the operational processes to identify areas for improvement and optimize the ecosystem's performance.

In summary, the governance of a human-centered, data-driven RedCLARA digital ecosystem is crucial for its success and sustainability. It involves establishing clear guidelines, frameworks, and policies to ensure ethical data practices, protect privacy and security, and foster collaboration among stakeholders. Effective governance ensures that the ecosystem operates in a transparent, accountable, and responsible manner, promoting trust and fairness among stakeholders. It also addresses legal and regulatory aspects related to data usage and establishes mechanisms for resolving disputes and ensuring compliance. By prioritizing human well-being, data integrity, and stakeholder engagement, the governance of the human-centered, data-driven digital ecosystem paves the way for the realization of its full potential in driving innovation, empowering individuals, and creating positive societal impact.

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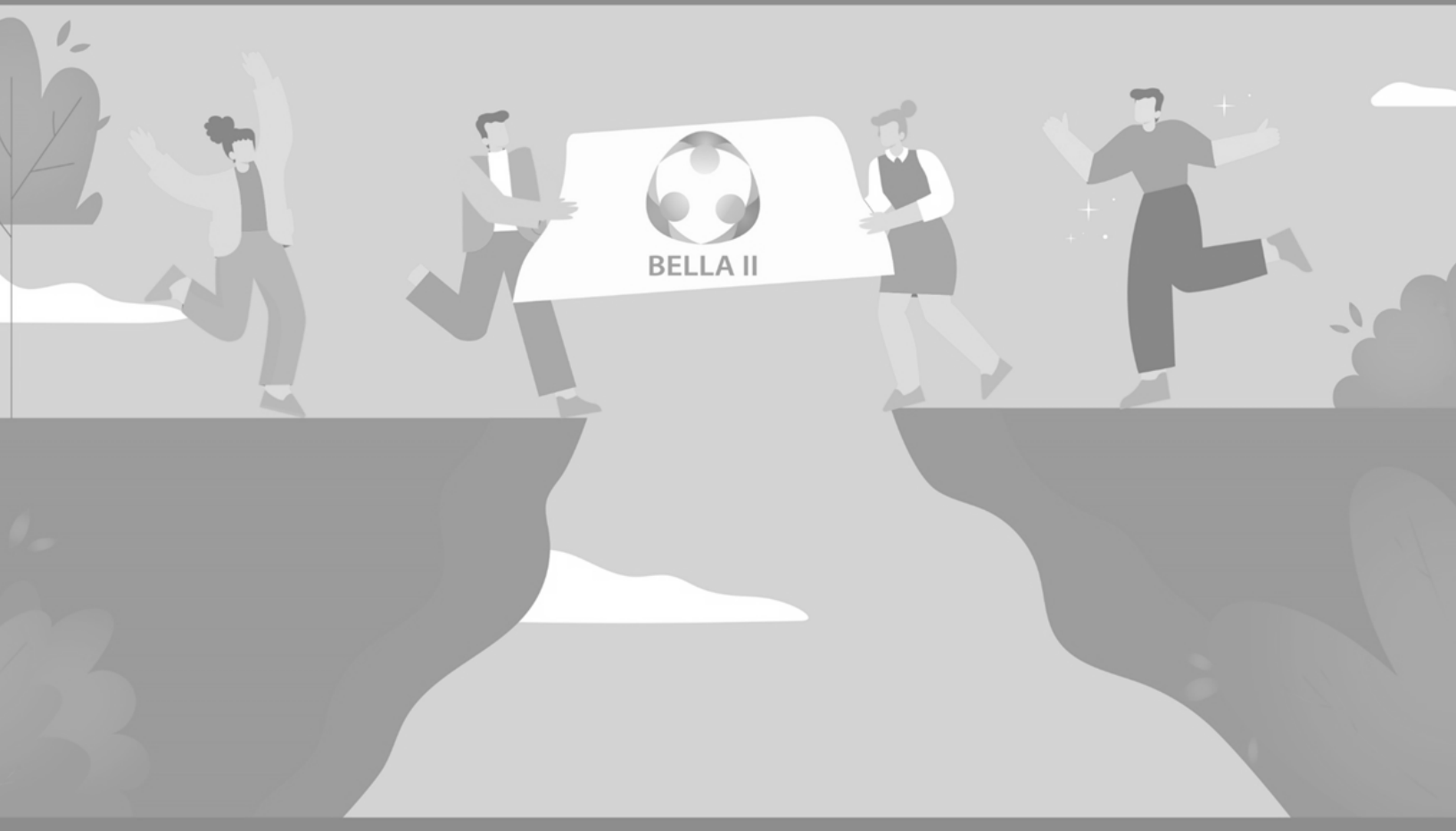

BELLA II receives funding from the European Union through the Neighbourhood, Development and International Cooperation Instrument (NDICI), under agreement number 438-964 with DG-INTPA, signed in December 2022. The implementation period of BELLA II is 48 months.

BELLA II

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