THE BLOCKCHAIN STRATEGY OF CATALONIA

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Working Group to Spearhead the Implementation of Blockchain Technology in the Activity of the government of Catalonia

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1. Introduction

Blockchain is technology that allows a set of transactions to be performed without previous trust among the parties and without the need for intermediaries. This technology guarantees the transactions and makes them irrevocable and transparent; everyone can check what transactions were made, which allows distributed consensus to be reached.

Blockchain is a distributed database which enables a permanent, immutable record of transactions to be kept securely. By using cryptographic keys and being distributed among thousands of computers, or nodes, it has many security advantages against any possible manipulation or fraud. It is a technology that has the potential to prompt a global change in the way traditional digital services are provided to the public sectors, industry and citizens.

Blockchain technology is part of a broader family of technologies called distributed ledger technologies, henceforth DLT, which we could define as replicated, shared, synchronised and geographically distributed computational systems with a mechanism of consensus for operating and storing information.

These technologies are known for initially being applied to record transactions associated with cryptocurrencies; however, today they are also beginning to be used for many other processes. In this sense, applications are already being developed in such different areas as administration, law, finance, the judiciary, medicine and energy, among others.

The innovative capacities afforded by blockchain technology and DLT are not going unnoticed, and more and more countries are beginning to explore how to use them in areas like digital identity, property registry, electronic voting, notary documents or cryptocurrency, just to cite a few. These countries are digital referents, including Estonia, Singapore, Japan, Australia, Sweden and the United Kingdom.

The implementation of blockchain technologies and DLT in the public administration opens up a range of opportunities that should be explored in order to set a suitable strategy that prioritises spheres of application and to evaluate its organisational, economic and technological impact. The ultimate goal is to take advantage of the benefits of blockchain in areas such as managing information more securely; optimising processes and lowering operating costs; enhancing the transparency of processes; authenticating identity more securely and quickly; ensuring data persistency and integrity; and saving in technological infrastructure, among others.

For this reason, having baseline knowledge and the capacity for technological development in this field is absolutely essential to successfully address the process of digital transformation in the Catalan public administration, as well as to become a country with the capacities and aptitudes to be competitive in
the new digital revolution in which advanced digital technologies, including blockchain and DLT, are becoming the engines of change.

Catalonia has capacities that make it a pole of attraction for the deployment of the technology, services and new business models associated with blockchain technologies and DLT. It is capable of becoming an international reference point for the development of this technology thanks to: its positioning as a country that attracts tech investment and generates digital innovation; the strength of a consolidated ICT (information and communication technologies) sector and an emerging ecosystem of blockchain technologies and DLT; and the government’s steadfast impetus to promote the potentialities of these technologies among the public administration, companies and citizens and to make Catalonia a pole of innovation, leadership and the attraction of talent and companies in blockchain technologies and DLT.

In this sense, on 24 July 2018, the government of Catalonia approved agreement GOV/65/2018, which promotes the implementation of blockchain technology in the activity of the Catalan public administrations with the following objectives:

a) to position Catalonia on the cutting edge in the use and development of blockchain technology;
b) to promote the public administration’s use of blockchain technology to provide better and more transparent services;
c) to foster knowledge, training and the creation of talent in the sphere of blockchain technology;
d) to promote research and innovation by R&D+i agents in this field by getting them involved in the quadruple helix (public administrations, companies, universities and civil society);
e) to promote the development of a new industry around blockchain technology; and
f) to promote the possibilities and potentialities of this technology among citizens in order to facilitate their adoption and encourage citizen participation.

The agreement stipulates the need to develop a plan to promote blockchain technology in Catalonia with the participation of the different ministries in the government of Catalonia. For this purpose, the Working Group to Spearhead the Implementation of Blockchain Technology within the Activity of the government of Catalonia was established with the following composition:

- **Sponsors.** The sponsor of the Working Group is the Catalan Ministry for Digital Policy and Public Administration, in conjunction with the Ministry of Foreign Affairs, Institutional Relations and Transparency, and the Ministry of Business and Knowledge.

- **Coordinator.** The Secretariat for Digital Policy is in charge of coordinating the Working Group and aligning its objectives and conclusions with the government’s country-wide strategic objectives.
• **Participants.** Representatives from different ministries and bodies of the government of Catalonia have participated in the group by providing different visions and perspectives from the public sector. Specifically, the following were represented:
  - the Ministry for Digital Policy and Public Administration
  - the Ministry of Foreign Affairs, Institutional Relations and Transparency
  - the Ministry of Business and Knowledge
  - the Ministry of Health
  - the Ministry of Territory and Sustainability
  - the Catalan Energy Institute (Institut Català de l’Energia, or ICAEN)
  - the ICT Social Health Foundation (Fundació TIC Salut Social, or TIC Salut Social)
  - the Metropolitan Transport Authority (Autoritat del Transport Metropolità, or ATM)
  - the Open Administration Consortium of Catalonia (Consorti Administració Oberta de Catalunya, or AOC Consortium)
  - the Information Security Centre of Catalonia (Centre de Seguretat de la Informació de Catalunya, or CESICAT)
  - the Telecommunication and Information Technologies Centre (Centre de Telecomunicacions i Tecnologies de la Informació, or CTTI)
  - the Consortium of University Services of Catalonia (Consorci de Serveis Universitaris de Catalunya, or CSUC)

• **Experts from the sector.** The different sessions of the Working Group enlisted the advice of renowned experts, who provided their technical vision of the development of blockchain technologies and DLT.

• **Support office.** The i2CAT Foundation has overseen the technical management of the Working Group by serving as a bridge between the experts and the participating ministries and bodies; providing and validating the set of technical contents dealt with during the sessions; and collecting the group’s contributions, requests and conclusions.

The conclusions of the Working Group have served as the foundation for the development of the Blockchain Strategy of Catalonia. Precisely one of the first proposals was to expand the scope of the strategy to all DLT technologies, blockchain technology being the most prominent.

In this sense, the government of Catalonia is spearheading the Blockchain Strategy of Catalonia, coordinated by the Secretariat for Digital Policy of the Ministry for Digital Policy and Public Administration. With this strategy, it will implement an action programme to support the development of the blockchain and DLT ecosystem in Catalonia around six strands: administration, promotion, innovation, ecosystem, talent and regulation.

In the chapters below, the Blockchain Strategy of Catalonia contains the characteristics and impact of the deployment of blockchain technologies and DLT, Catalonia’s capacities for this deployment and
the policies that the government of Catalonia will launch in order to become a global success story in the use and development of blockchain technologies and DLT.

2. Blockchain and the impact of its deployment

2.1 CHARACTERISTICS OF BLOCKCHAIN AND DLT

A blockchain is a distributed, decentralised database, and therefore a DLT; it is made up of chains of blocks designed to prevent them from being altered once the data has been published using a digital seal in time and linking one block with the previous one. It allows transactions between two participants to be conducted securely, reliably and irreversibly, without the need for an intermediary or a central authority that establishes trust between the parties or verifies the transactions. The main features provided by this technology are:

- **Transparency**: Any user can have access to the data using public interfaces and freeware.

- **Immutability**: The records of the different events or interactions with the systems remain immutable once they are validated in the system, and it is computationally impossible to change a record after it has been added.

- **Distributed resilience**: The systems do not depend on a centralised node for storage or computational capacity. The system is replicated and distributed redundantly in a large web of nodes, which are often maintained and managed via an incentive.

- **Disintermediation**: The presence of a mediating agent to validate the operations among the different users is unnecessary, as they can intrinsically trust the distributed consensus mechanism.

- **Automation**: The systems allow complex algorithms to operate automatically in order to execute specific actions under given conditions.

- **Intrinsic cybersecurity**: The systems use cryptographic techniques that guarantee users’ authentication and authorisation to operate them, as well as to guarantee the stability and appropriateness of the transactions.

The main motivation for blockchain technology is one of bringing intrinsic trust to a network where a distributed system is deployed by delegating it to a consensus system which has to be validated and accepted by the vast majority. Furthermore, it also provides cryptographic security and is designed to be resilient to attacks.
DLT technologies, including blockchain, are particularly useful for managing citizen services in such a way that this kind of consensus-based network can be deployed to increase transparency and guarantee citizen trust while also providing the solution with integration and robustness.

However, DLT technologies also entail a series of risks which must be borne in mind when developing solutions or applying this technology in different areas:

- **Management of the network and consensus algorithms**: Generally speaking, consensus attacks by actors capable of controlling more than 51% of the infrastructure that allows the technology to operate have been identified as one of the most important risks to bear in mind. Therefore, it is essential to develop solutions that allow any change in the consensus algorithm to be monitored, reviewed and managed, in addition to a previous quantitative study regarding the scale of the network (the larger it is, the less likely it is for these attacks to occur).

- **Cryptography and the management of cryptographic keys**: In terms of cryptography and key management, the problem of defining the processes used to manage keys that require appropriate auditing, monitoring and maintenance has been identified as a risk common to all DLTs and related systems.

- **Permits and privacy in DLT**: In private networks, the validation of permits and privacy mechanisms deserve special consideration. Users, groups and roles have to be very carefully considered, as do the processes to monitor new additions and withdrawals in order to prevent risks.

- **Data management**: Likewise, from the standpoint of confidentiality, integrity and compliance with the General Data Protection Regulation (GDPR), specially protected data should not be stored in public chains.

- **Defence mechanisms**: A necessary counter-measure is required which would entail a complete audit of implementations in order to avoid possible attacks and/or errors, especially with regard to smart contracts.

- **Scalability and performance**: In the world of cryptocurrencies (first widespread applications), problems have already been detected in terms of the number of transactions that can be allowed per time unit, as well as the amount of computational resources they consume (which have a significant environmental impact related to the mining and working tests of some consensus algorithms).

- **Governance**: Furthermore, it is important to plan for potential governance crises; that is, at some point in time, different actors that support the ecosystem may disagree on something such as the choice of a given change and/or overall strategy, leading the community to break down, prompting a loss of value and trust.
2.2 Sectors impacted by blockchain and DLT

The possible applications of these technologies are predicted to be diverse, and they can be applied to many different sectors. However, we must monitor which ones are ultimately adopted by industry and society and which ones remain as mere concept tests. Different studies and reports have described possible applications in a host of sectors, such as:

- real estate
- energy
- the Internet of Things (IoT)
- industry
- business services
- entertainment and music
- teaching
- government
- financial services
- logistics and supply chain
- healthcare
- food
- tax management and payments

The figure below shows some of the impacts of blockchain and DLT in the demand sectors:

*Figure 1 – Recent and prospective applications in the demand sectors.*

*Source: Blockchain in Catalonia technical report - Government of Catalonia*
2.3 Applications in public administrations

Without a doubt, the main motivation behind blockchain technology is to bring intrinsic trust to a network where a distributed system is deployed by delegating it to a consensus system which has to be validated and accepted by the vast majority. Furthermore, this technology provides cryptographic security and is designed to be resilient to attacks.

This is why the application of distributed DLT technologies is particularly useful for managing public services with the goal of increasing transparency and guaranteeing citizen trust, while also providing integration and robustness to the solutions.

In the sphere of the public administration, some of the possible applications which could be applied, for which references from other countries already exist, are:

- **Digital internet**: Distributed ledger systems allow their users to have an identity with which they can act on the platform. Yet that is not all: other inherent attributes of the individual (height, age, date of birth, fingerprints, etc.), attributes accumulated over time (medical records, preferences, communication metadata, etc.) and assigned attributes (telephone number, email or national identity document number) can also be associated with their digital identity so that it is unique and traceable. This information is never saved directly on the chain but is associated with it via cryptographic keys which allow the data to be verifiable.

- **Citizen participation, voting and liquid democracy**: One of the main challenges in a democracy is the possibility of creating reliable, secure citizen participation processes while maximising transparency and ensuring that votes are not traceable. This process is quite costly if done with physical urns, yet it is difficult to make secure if done by centralised electronic voting platforms. Thanks to distributed ledger technologies with a good digital identity system, these processes can be undertaken in an economical, secure way without compromising the anonymity of the votes.

- **Public procurement**: The creation of platforms where public contests and tenders can be processed using distributed ledger technologies is a simple, powerful application because of its benefits in terms of transparency, immutability, identity and the transmission of value. Thus, the potential for fraud and corruption associated with tenders can be minimised.

- **Notarial recording and document verification**: Until now, documents had to be verified via a notary or trusted third party who could certify the validity of the document. This could lead to the falsification of documents, among other consequences. Therefore, the implicit immutability and distributed security of distributed ledger technologies make them very appropriate for applications like these.

- **Subsidies**: With distributed ledger technologies, the distribution and delivery of subsidies can be much more transparent, and the traceability of their application can be ensured, which opens the
door to new assistance models geared at very specific expenditures which can then be carefully and reliably monitored without the associated bureaucracy.

- **Records**: It is very important for records to always be kept up-to-date and for the information contained in them to be truthful. With the help of the immutability and decentralisation of distributed ledger technologies, this is heavily optimised because previous information cannot be so easily changed, while new information is real. Some of the records which are being digitalised in other countries include records on parking, licenses, social security, employment, business, property, education, etc.

- **Health records**: Health records deserve special attention. Patients, suppliers and healthcare organisations can work together using blockchain and other distributed ledger technologies. The main use cases are related to domestic interoperability, medical record accessibility, precision medicine, smart contracts, patients’ digital identity, clinical research and cybersecurity.

- **Supply chain management**: The capacity of distributed ledger technologies to allow for consensus among actors who do not trust each other without the need for intermediaries, coupled with the inherent transparency and immutability of these systems, makes them ideal for overseeing supply chain management.

- **Energy markets**: The use of distributed ledger technologies enables an energy credit market that seeks to encourage the production of renewable energies to be managed.

- **Government bonds**: Because distributed ledger technologies allow for the creation of digital assets which are identifiable and transferrable via rules defined in the protocol, it is quite easy to represent bonds and other financial assets in this way.

- **Tax payments**: Many taxes, especially indirect ones, such as retail and environmental taxes, stem from chains of transactions, and the tax obligations generated therefrom are activated by certain acts which have to be securely documented and filed (such as the delivery of goods, the termination of a contract, etc.). Distributed ledger technology allows taxable transactions to be registered on the same database in real time, which in turn enables the parties involved (taxpayers, banks, tax administration, etc.) to check them and some of the tasks to be automated (such as tax payments or the application of tax benefits) via smart contracts. These functionalities make it possible to lower tax fraud and compliance costs.
3. Available capacities in Catalonia

Catalonia has capacities that make it a pole of attraction for the deployment of the technology, services and new business models associated with blockchain technologies and DLT. It is capable of becoming an international reference point for the development of this technology thanks to: its positioning as a country that attracts tech investment and generates digital innovation; the strength of a consolidated ICT sector and an emerging ecosystem of blockchain technologies and DLT; and the government’s steadfast impetus to promote the potentialities of these technologies among the public administration, companies and citizens and to make Catalonia a pole of innovation, leadership and the attraction of talent and companies in blockchain technologies and DLT.

The sections below present each of these capacities which make Catalonia an ideal place for the development of blockchain technologies and DLT.

3.1 Catalonia, best region for investment in southern Europe

The Financial Times publication “fDi Magazine” has recognised Catalonia as the most attractive region in southern Europe for foreign investment in 2018 and 2019. This is one of the most prestigious international rankings which uses multinationals to study future business investment projects.

What stand out are investments made by multinationals and start-ups in the ICT sector (28.6% of the total in 2017), a sector that generates wealth and skilled jobs which has a strong potential for growth and exerts a "pull" effect on the tech sector of the Catalan economy.

As a whole, investors perceive Catalonia and Barcelona as very attractive places to invest. Catalonia has an overall score of 3.7 on a scale of 1 to 5, in which 5 indicates a “very attractive place to invest”. Asian companies rate the region the highest, with 3.73 points, followed by European and American companies, with respective scores of 3.7 and 3.65.

If we focus on the digital ecosystem, Barcelona is the leading hub of start-ups in southern Europe in sheer numbers and fifth in Europe after London, Berlin, Paris and Amsterdam according to the Ranking of Europe’s Biggest Startup Hubs in 2017 drawn up by EU-Startups.

Indeed, Barcelona is considered the third favourite hub of start-up creators: 20% of European start-up founders would choose this city for their start-up, followed only by London and Berlin, as reported in the Startup Heatmap Europe 2018.

On the other hand, according to the Digital Start-up Ecosystem Overview developed by the Mobile World Capital Barcelona Foundation, the entrepreneurial and start-up ecosystem invested 871 million
euros in Barcelona in 2018, which accounts for 66.4% of investment in Spain as a whole, and it is the fifth-ranked city in Europe in terms of the volume of investment received in start-ups.

3.2 Strength of the ICT sector in Catalonia

The ICT sector, one of the most dynamic in the Catalan economy, has one of the most important industrial clusters in Europe, along with a highly competitive group of software developers. This gives it a strong capacity to generate innovative solutions adapted to the vertical reality of industry or services, in addition to the fact that these solutions are validated or even co-created by future users before being brought to market.

In consequence, the ecosystem generated in the Catalan ICT sector stems from an unprecedented agglutinative capacity and is among the most competitive and dynamic in Europe.

3.3 The blockchain ecosystem in Catalonia

According to the *Blockchain in Catalonia* study developed by ACCIÓ-Business Competitiveness Agency (ACCIÓ-Agència per la Competitivitat de l’Empresa), in July 2018, 35 companies were detected that currently have a low economic impact yet a high potential for growth. Therefore, this is an emerging
ecosystem primarily made up of micro-businesses, in which 60% of the companies are less than four years old.

Another key area in the development of blockchain technology is the impetus for research and innovation and technology transfer. In this sense, the study identifies three TECNIO centres which develop blockchain technology: Eurecat (Technology Centre of Catalonia), the i2CAT Foundation and the Centre Easy.

- **Eurecat** was founded from the merger of different tech centres and brings together more than 600 professionals in a wide array of fields of expertise, both industrial and digital. Some of its Industry 4.0 areas of research include new manufacturing processes, autonomous robotics, simulations, 3-D printing, big data and IT security.

  In the sphere of science, blockchain for Eurecat means new avenues of exploration in the preservation and management of digital identities, user authentication, and the information generated on the Internet of Things and Industry 4.0. The platform members can access training activities, intensive courses, master classes, informative sessions and international lectures in blockchain applications. Eurecat has joined the Blockchain Observatory to help implement this technology in the business sector and industry.

- **The i2CAT Foundation** is a research centre whose objective is to spearhead RDI activities in the fields of advanced Internet architectures, applications and services. The centre leads avenues of research into blockchain and Internet architectures, content-based multimedia technologies and services and applications in the fields of eHealth & Social Care, IoT & Smart Cities and Regions and Industry 4.0.

  The blockchain ecosystem and the i2CAT Foundation enable digital infrastructures to be created more quickly and collaborative systems to be provided for nodes housed in different participants and distributed ledger technology services.

- **The Centre Easy** carries out basic research in the field of artificial intelligence combined with technology transfer in many applied research projects. The mission of this centre is to create leaders in technology innovation and to undertake research projects connected to the real world.

  The Centre is an expert in virtual currencies (an unregulated kind of digital money usually issued and controlled by its developers and used and accepted by the members of a specific virtual community) and digital preservation (a formal effort to ensure that valuable digital information remains accessible and usable).

The ecosystem is also comprised of entities and initiatives that support the development of the sector, such as communities, events, training organisations, accelerators, associations, etc. Below is a map of the companies and entities related to blockchain in Catalonia.
On 24 July 2018, the government of Catalonia agreed to promote the implementation of blockchain technology in the public administration’s activity with the goal of improving digital citizen services and promoting the potentialities of this technology among the administration, companies and citizens.

With the agreement, the government positioned Catalonia on the vanguard in the use and development of blockchain technologies and DLT, and to do so, it is promoting the Blockchain Strategy of Catalonia, a country-wide strategy which seeks to: foster knowledge, training and talent-creation in the field of DLT; promote research and innovation in this field; foster the development of a new industry around it; and promote the potentialities of this technology among citizens, companies and administrations in order to facilitate its adoption.
4. The Blockchain Strategy of Catalonia

The impetus of blockchain technologies and DLT are a priority for the government, which wants to support the deployment of these technologies in different spheres of society and make Catalonia a hub of innovation, leadership and the attraction of talent and DLT companies.

In this sense, the government of Catalonia is promoting the Blockchain Strategy of Catalonia, coordinated by Secretariat for Digital Policy of the Catalan Ministry for Digital Policy and Public Administration. Via this strategy, it plans to deploy a series of actions to support the development of the blockchain and DLT ecosystem in Catalonia.

The objectives associated with the deployment of the strategy are:

- to position Catalonia on the cutting edge in the use and development of blockchain and DLT,
- to promote the public administration’s use of blockchain technologies and DLT,
- to foster training and the creation of talent in the field of the blockchain technologies and DLT,
- to promote research and innovation by RDI agents in this field and to get the agents in the quadruple helix (public administrations, companies, universities and civil society) involved,
- to promote the development of a new industry around these technologies, and
- to promote the possibilities and potentialities of blockchain technologies and DLT among citizens to facilitate their adoption and encourage citizen participation.

The strategy will deploy a series of actions around the following six strands:

- **Administration**: Improving public services through the adoption of blockchain technologies and DLT and making the government of Catalonia a pioneer in their application.
- **Promotion**: Positioning Catalonia as a benchmark in blockchain and DLT on the international tech map and disseminating the opportunities and impact generated by their deployment.
- **Innovation**: Promoting research and innovation through research and technology centres, and developing innovation environments to encourage their adoption in different sectors.
- **Ecosystem**: Cultivating a new industry around blockchain technology and DLT and promoting the demand for services and solutions associated with top-priority vertical sectors.
- **Talent**: Generating, retaining and attracting talent, both technological and entrepreneurial, with the knowledge and capacities needed to develop this new industry.
- **Regulation**: Analysing the implications of the regulations on the deployment of this technology, as well as how to regulate the applications that use it.
4.1 Strand 1 - Administration

4.1.1 Programme to detect opportunities

In order to encourage the public administration’s use of blockchain technologies and DLT, the first action strand is to launch a programme to detect and analyse both use cases and opportunities for improvement by the different ministries and bodies within the government of Catalonia.

The purpose of the programme is to determine what benefits this type of technology could bring to both the government of Catalonia and to citizens in terms of specific applications.

All of this, coupled with the need to guarantee the suitability of the use cases and their approach, as well as to lay solid groundwork for their implementation, creates the need to establish a common analysis methodology to be used by all the ministries.

4.1.2 Methodological proposal to address the projects

In order to address the implementation of projects that use blockchain technologies and DLT in the government of Catalonia in a coordinated fashion, and to ensure their success, a methodological proposal of the necessary requirements is set forth, which can serve as a minimum justifying point of departure prior to the implementation of the solution.

The points which have to be developed and documented before beginning the project are:

- **Detection of needs/opportunities for improvement**: To make a detailed analysis of the needs and objectives and not ignore the fact that the use case to be implemented may be incompatible or forced with DLT.

- **Search for similar application cases** around the world and in other ministries of the government of Catalonia.

- **Detailed analysis of the legal framework** and of how to avoid regulatory conflicts, such as with the General Data Protection Regulation (GDPR), the Regulation on Electronic Identification and Trust Services for Electronic Transactions (elDAS) and others.

- **Focus on the solution**: A first iteration of the types of technologies which the solution could admit, with their pros and cons.

- **Risk analysis**: Once the type of solution has been defined at a high level (without specifying its implementation), a risk analysis can be conducted.
• **Technological proposal:** Finally, bearing in mind all of the above, the specific implementations of the different technologies have to be evaluated in order to ascertain which is the most appropriate in the development of the specific solution.

4.1.3 Technological infrastructure

Once the use cases and/or opportunities for improvement have been detected and the projects defined following the methodology outlined in the previous point, concept tests associated with the different prioritised use cases will begin. In this sense, the use of a shared hardware and software model among the different ministries and institutions will be considered a priority, and even the integration of other actors from the public sector to avoid creating multiple micro-networks with similar technology and governance. This could lower deployment costs and facilitate knowledge transfer.

Even though at first this kind of technology was deployed openly and publicly to accept cryptocurrencies – such as bitcoin and Ethereum – without any government control, within the scope of the public administration, and in particular the government of Catalonia, it is recommended to weigh the first deployment option of this kind of solutions privately and/or with permission through an authorisation system under the control of the public administration or the department with competences on the matter while ensuring full compatibility with the use of self-sovereign digital identities.

In terms of the management of citizen digital identity in the systems for the concept tests, in this first stage, it is recommended that private individuals be used for each case, without discounting the possibility of consolidating a transversal system in the future.

4.1.4 Launch of a sandbox-type test environment

Blockchain technologies and DLT are considered immature technologies with a great deal yet to be done, tested and approved. In this sense, it is considered essential to establish a test environment in which the different areas within the government of Catalonia and other public-sector agents can test projects in a controlled environment and with specific set of rules in order to analyse their functioning and detect any problems that may occur in a real situation.

In this sense, the creation of a sandbox or test laboratory will be promoted, with a particular emphasis on ensuring that the proposed laboratory is as agnostic as possible and capable of being compatible with different technologies.
4.1.5 Training plan for public administration staff

In order to be able to offer this capacity for citizen engagement to increase citizens’ participation and trust in the new systems, previous appropriate training will be provided to public administration professionals and technicians in all areas in order to train them on how to properly manage the opportunities and risks, as well as to share with citizens the type of empowerment that these technologies make possible.

4.1.6 Observatory of blockchain technologies and DLT

Given the speed with which this kind of technology is being developed and implemented around the world, an observatory of blockchain technologies and DLT will be launched. It will be charged with identifying, classifying and analysing the trends, evolution, technological development and deployment of blockchain technologies and DLT both domestically and internationally, as well as evaluating the different initiatives underway in Catalonia and sharing the conclusions and knowledge generated.

This observatory’s specific mission will be:

- To periodically report on new initiatives related to blockchain technologies and DLT around the world, with a special emphasis on those related to the public administration.
- To identify and choose good practices related to concept tests, use cases and projects developed with blockchain technologies and DLT.
- To draft reports compiling knowledge around blockchain technologies and DLT which can serve as an instrument to disseminate these technologies to different groups.

4.1.7 Deployment of use cases

Bearing in mind the different points discussed in this chapter, the different areas of the government of Catalonia will spearhead the development of concept tests and projects which use blockchain technologies and DLT with the goal of improving digital citizen services.

In this sense, and as the outcome of the work done by the Working Group to Spearhead the Implementation of Blockchain Technology in the Activity of the government of Catalonia, below is a list of the potential use cases proposed so that experimentation with the different technologies can begin, taking into account the methodology outlined in section 4.1.2:
Healthcare policy
To develop a specific action plan aligned with the Catalonia Health Plan currently in force, led by the Department of Health and the ICT Social Health Foundation, with the goal of promoting innovation in the field of healthcare.
Cases could include citizen empowerment over their patient records, as well as analysing DLT systems to establish a shared protocol which would improve the efficiency of data-sharing and the integration of the different healthcare management systems.
Possible examples of use cases in this area would be:
• A system to manage access to patient records that would empower the healthcare system users.
• Audited sharing of anonymous data among consortiums of healthcare centres and research entities in order to conduct clinical studies while ensuring the accuracy, authenticity and quality of the information, making it possible for the validation to correspond to real patients while respecting their anonymity.
• In terms of non-anonymous data: a healthcare identity system such as the one outlined can facilitate the implementation of data-donation campaigns with authorised consent while eliminating the need for many of the slow, bureaucratic processes currently involved today.
• A DLT traceability system of pharmaceutical products in order to audit the lifetime of a medicine from its synthesis and formulation to its consumption by the patient. The main benefits are an increase in security in terms of the formulation and administration of medicine, as well as making a much more detailed analysis of pharmaceutical spending possible.
• Development of a proposal for a consortium-based integration plan of healthcare information systems, both public and private; these technologies make it possible to intrinsically validate the integration of the different systems while establishing an all-or-nothing security criterion such that once the systems are integrated, the robustness of solutions can be considered guaranteed.
• Development of proposals for an informed consent form shared by all providers within the SISCAT.
• Development of shared digital certification forms for prescription forms.
And others according to the information-sharing needs determined by the Department of Health.

Curricular development and innovation in the educational system
Given that one of the most widely explored applications in DLT in the field of education is curricular records and certification, and that curricular development is one of the competences of this department, one of the first actions to undertake is launching a pilot plan with the objective of integrating different institutions, both public and private, in order to operate with a standard curricular certification model.

Policy on social services, benefits and protections
The use case would entail beginning to conduct a study to detect the key points in preventing fraud, as well as automating benefits to the extent possible in cases which require it, facilitating integration among different ministries. DLT technologies may make it possible to exhaustively trace when benefits
are granted under fraudulent conditions, as well as facilitating the paperwork needed to secure these benefits if the applicant meets the stipulated conditions. One example could be the management of assistance in energy vulnerability cases.

**Mobility and public transport**

Within the new mobility of the future resulting from the digital transformation of transport, mobility as a service (MaaS) is one of the foremost trends. MaaS combines public transport and other private mobility service operators, plus staff, who are also shared, in a new mobility value chain in which users have E2E (end-to-end) access. Given the clear need for public leadership, and the need to ensure that collective public transport forms the backbone of this new value chain, the ATM is working to spearhead the technological platform and transversal management of this new scenario, which necessarily entails public-private cooperation, in addition to participating actively in benchmark international institutions. Even though they are still incipient, blockchain and other DLT technologies are being called to play a facilitating role in secure, transparent access to mobility services, called smart contracts, as well as in exploring other ways of managing data in real time and 5G technology. Blockchain may be an appropriate tool in fields like driverless mobility, which is beginning to take root in some cities. In Catalonia, for example, several concept tests and pilot tests have already been conducted (such as Èrica). Blockchain’s decentralised management in certain aspects of services provided by private mobility operators can also bolster the resilience of the transport system, such as in situations when the service is disrupted or cases of overbooking, and it can facilitate and promote the transparency of the market of participants in the system. In any case, the “virtues” of blockchain, such as decentralisation, can never run counter to the organising, supervisory role of public administrations in mobility in general and in public transport specifically, which, as a critical infrastructure, has an eminently social purpose.

**Policy on land-use planning and urban development: Land-use policies**

One of the use cases is related to the land registry and commercial activities. The immutability of the registries of these technologies could be used to take advantage of studying how an efficient, decentralised public property registry system could be implemented. One example would be its application to the land registry and the property registry.

**Promotion of renewable energies and waste treatment**

One area worth analysing is how DLT technologies can encourage responsible energy consumption and sustainability in terms of waste treatment and generation according to incentives encouraging citizens, companies and the public administration to adopt a sustainable model in the short term around the country. Another sphere of application would be the use of DLT technologies to manage an energy credit market aimed at encouraging the production of renewable energies.
Universities and research
DLT technologies may prompt significant headway in their application in the sphere of public and private technology consortia, and therefore they could become a differential factor in research and knowledge transfer from universities and research centres to the industrial sectors. On the other hand, they could make it possible to integrate certification into higher education in order to be internationally recognised in a consortium-based network.

Domestic and foreign trade and tourism
Promoting the traceability and reliability of supply chains among multiple agents such as manufacturers, cooperatives, intermediaries, etc., is one of the most suitable use cases of DLT technologies, which would make it possible for consumers to trust the origin of products regardless of all the agents that intervene in the manufacturing, processing, distribution, transport and sale process. One example in this could be the international auditable traceability of products originating locally and the implementation of distributed platforms to encourage tourism and local retail.

Agriculture, livestock and fisheries policy: Agro-food industry
Just as in the case of retail, one possible use case could be a distributed system which ensures trust in the food supply chain and could maintain internationally-recognised designations of origins. The fact that even though they are validated, DLT networks can be open to be read on the public Internet in cases that do not involve personal data, could facilitate the adoption of a local product verification and validation system that could be used by any commercial entity around the world, while also facilitating consumer recognition.

Transparency and open-government policies
Transparency and open-government policies are necessary when defining the criteria used to apply these technologies. One example could be the implementation of a citizen consultation and participation system based on DLT technology. A system developed with this technology could be immediately auditable with the trust of citizens and institutions. Additionally, it would allow citizens to openly and transparently trace the status of the different projects being executed by the public administrations resulting from their election, thus encouraging participation while breaking down the public administration/citizen barrier.

Management and oversight of public procurement
Public tenders based on DLT technologies can improve the establishment of the criteria, oversight and monitoring of public procurement. One example would be considering the possibility of devising smart contracts which would make it possible to automate or semi-automate competitions and tenders while rendering fraud and unauthorised information leaks impossible.
Public finances, budgets and spending efficiency
From the standpoint of the department’s functions, public finances, budgets and spending efficiency should be highlighted as prime areas for the application of DLT technologies, inasmuch as they can attain a degree of transparency, control, efficiency and ease of integration which would be impossible with any other type of system. One example of this is monitoring the public sector’s activity in an auditable way in accordance with compliance with the economic and budgetary regulations.

Competences with regard to associations, foundations, professional associations, notaries and registrars
One of the possible applications of DLT technologies is to facilitate an open, public infrastructure to digitally sign documents; internal elections in associations; and the registry of new members and withdrawals in different organisations. The government of Catalonia could implement a secure infrastructure with permits to provide access to these highly resilient services and allow for this kind of use case, such as to notarise documents.

Management of the tax administration
The immediate, automatic use of verifiable information could help lower tax fraud and errors, while also helping lower the administrative burdens on taxpayers to fulfil their different tax obligations. From the standpoint of the tax administration, management efficiency would increase considerably, especially the kind related to taxation aspects that require high levels of documentary proof and complexity, such as matters related to property, while it could also help fulfil immediate obligations which depend on fulfilling registrable acts.

4.2 Strand 2 - Promotion

4.2.1 Dissemination and awareness-raising programme
Promoting and disseminating blockchain technologies and DLT is essential to foster the blockchain and DLT ecosystem in Catalonia, as well as to promote the demand for innovative services in strategic sectors. With this goal in mind, a dissemination programme will be implemented in order to share the opportunities and impact generated by blockchain technologies and DLT and to promote the development of projects with these technologies.

It is also necessary to share with citizens the idea that a paradigm shift is underway, and that the monolithic, centralised systems of today are being replaced with much more dynamic and resilient services in which they will be able to participate in the near future. In this sense, informative citizen actions will be undertaken with the goal of helping them understand the transformative potential of these technologies in terms of the decentralisation of organisations and individual empowerment.
With the same goal in mind, informative materials will be developed to report on DLT technologies and their potential, addressed both to citizens, so that they understand how they work, and to professionals, so that they are aware of the advantages and disadvantages and can apply them in their services or solutions.

### 4.2.2 Blockchain Solutions World

Blockchain Solutions World will be held as part of the IoT Solutions World Congress. The former is the leading global event in blockchain solutions which gathers together professionals from all over the world who specialise in DLT technologies and helps connect these professionals to those from industrial sectors who visit the fair to learn first-hand about the impact these technologies will have in their industries.

The Congress’s approach is based on practical solutions and cases, and it is a promotional tool for organisations that want to describe the most successful implementations of blockchain technologies and DLT in their solutions and services.

The government of Catalonia has been one of the driving forces behind Blockchain Solutions World through its institutional support. This translates into a strong Catalan presence, as well as activities that seek to bring visibility to blockchain initiatives in Catalonia.

### 4.2.3 Barcelona Blockchain Week

Barcelona Blockchain Week is held within Blockchain Solutions World; the former is an initiative promoted in a decentralised fashion by the blockchain community of Barcelona and Catalonia which hosts a series of activities related to blockchain technologies and DLT during the week the fair is being held. Informative sessions, thematic lectures, gatherings of professionals in the sector, visits to institutions and other activities are held to share the technology and its potentialities.

The government of Catalonia is one of the entities promoting Barcelona Blockchain Week, and it participates by supporting some activities and directly organising others, such as the Catalonia Blockchain Tour to introduce the Catalan companies participating in Blockchain Solutions World.

### 4.3 Strand 3 - Innovation

#### 4.3.1 Advanced digital technologies programme
The government launched the Advanced Digital Technologies Research and Innovation Programme, which is spearheading a mission-driven and dual-use model geared at the government’s strategic objectives in order to rise to the country’s challenges. This programme focuses on innovative solutions, including a priority focus on the use of blockchain technologies and DLT.

Some of the challenges presented in this programme may be resolvable with the use of blockchain technologies and DLT. One example is the challenge of the traceability and circularity of electrical and electronic devices and their waste; in this case, the goal is to develop a project that demonstrates the feasibility of having a system that allows the EEDs (electrical and electronic devices) sold in Catalonia to be traced and located, starting from the moment they are manufactured.

The project also seeks to create a chain of trust so that the economic outlays that EED manufacturers have to make in order to properly manage WEED (electrical and electronic device waste) are distributed securely and honestly among the different agents involved.

Additionally, the programme will also encourage cooperation among research and technology centres specialising in these technologies with the goal of generating synergies and collaborations among themselves and with the different stakeholders in the Catalan ecosystem to boost their activity and develop a shared vision of the prioritisation of research and innovation in this field.

4.3.2 Catalonia Blockchain Living Lab

In section 4.1.4, we outlined the need to have a sandbox-type test environment where the different areas of the government of Catalonia and other agents in the public sector can test projects in a controlled environment and with specific set of rules in order to analyse their functioning and detect any problems that may occur in a real situation.

Likewise, in order to promote cooperation among companies, research centres and public administrations in the development of concept tests and innovative solutions, the Catalonia Blockchain Living Lab will be promoted, a blockchain test environment where projects created by citizens, the public administration and companies headquartered in Catalonia can be developed.

4.3.3 Catalonia Blockchain Challenge

In order to get developers, entrepreneurs, start-ups and small and medium-sized companies in the Catalan blockchain ecosystem involved in creating new technological solutions, we will hold the Catalonia Blockchain Challenge, a competition that connects the problems and challenges posed by the public administrations and entities in the country with the proposals provided by the blockchain ecosystem in Catalonia in order to develop concept tests and innovative solutions which meet these
challenges. These solutions may be implemented in the Catalonia Blockchain Living Lab in order to be validated.

### 4.3.3 Convergence of artificial intelligence, the Internet of Things and blockchain

The convergence of digital technologies like artificial intelligence, the Internet of Things and blockchain will enhance the momentum of the digital transformation in the forthcoming years, which will give rise to a more connected, efficient and secure world. Therefore, promoting RDI projects which connect the world of blockchain technologies and DLT with the worlds of artificial intelligence and the Internet of Things (and 5G) will be strategic to lay the groundwork for what will become the new Internet revolution.

### 4.4 Strand 4 - Ecosystem

#### 4.4.1 Public-private cooperation to boost the sector

With the goal of enhancing Catalonia’s blockchain ecosystem and turning Barcelona and Catalonia into an international pole of reference in this technology, a public-private collaborative environment will be promoted with the participation of companies, technology centres, universities and other driving forces in order to establish a joint strategy to boost the sector.

This new space will allow the different agents participating in the sector to coordinate in order to find synergies, complement each other when addressing larger-scale projects, foster existing initiatives or create new ones.

#### 4.4.2 Entrepreneurship programmes in the blockchain environment

Blockchain technologies and DLT help generate new services which can be provided to the different areas within the productive and social sectors. To do so, new entrepreneurship projects must appear with the objective of implementing and commercialising these services.

In this sense, within the framework of the government of Catalonia’s Catalunya Emprèn programme, projects will be promoted to foster entrepreneurship in the blockchain technology and DLT environment while also prioritising this technology in transversal technology programmes.

On the other hand, the creation of innovation and entrepreneurship spaces for companies in the blockchain sector will be promoted so that the new companies have the space and resources to be able to launch their activities with lower entry barriers.
4.4.3 Sectoral promotion programme

The solutions created with blockchain technologies and DLT have a transformative potential in the leading business sectors in our economy, but it remains to be seen which end up being adopted by industry and society and which remain at the concept test stage.

In this sense, a sectoral promotion programme will be devised with the goal of developing vertical services and solutions adapted to the sector’s needs. To do so, co-creation activities will be held to generate projects which bring the supply and demand from different vertical sectors together in the same space in order to analyse potential use cases and identify pilot projects and concept tests.

4.5 Strand 5 - Talent

4.5.1 Training programmes in blockchain technologies and DLT

Talent is the indispensable raw material needed to promote the development of the blockchain ecosystem in Catalonia, so having training programmes that match this sector’s needs is strategic for the country. Currently, although there are some initiatives which provide training in blockchain technologies and DLT, the range of training options in this field is quite limited, and therefore it is essential to foster the creation of new training programmes while enhancing those that already exist.

However, it is also important to focus on the current technology curricula in secondary education, baccalaureate, vocational training and university degrees in order to include contents related to this new type of technologies, ultimately to train the upcoming generations in their specificities and transformative impact.

4.5.2 Barcelona Digital Talent

In order to ensure the competitiveness of Catalonia and Barcelona as a technology hub in blockchain technologies and DLT, Barcelona has to position itself as a city capable of generating, retaining and attracting talent with the knowledge and capacities needed to develop this new industry. To achieve this, efforts will be funnelled through the Barcelona Digital Talent programme in order to identify Barcelona and Catalonia as a reference site for developing one’s career and/or pursuing training in blockchain technologies and DLT.

The Barcelona Digital Talent programme is an alliance to position the city of Barcelona as a pole of digital talent in order to rectify the lack of digital talent in the city and increase the number of tech-based businesses which need employees with digital competences. In this sense, the talent associated
with the development of blockchain technologies and DLT will be prioritised within the programme, but not centred solely in Barcelona; instead, this factor aimed at generating, retaining and attracting talent will extend to the rest of Catalonia as well.

4.6 Strand 6 - Regulation

4.6.1 Impact analysis of regulations

There is no specific regulation of blockchain technologies and DLT, which means that there are legal gaps and dubious areas regarding how a legal conflict would be resolved. This affects many blockchain projects, some of which have gone to other countries to move forward.

In this sense, a working group would be created to undertake a detailed analysis of how regulations can affect the different solutions which serve as the groundwork for developing new projects to promote the use of this technology. This group will also be responsible for anticipating proposals in order to define a regulatory framework that is favourable to the use of DLT technologies.

4.6.2 Analysis of the implications of the General Data Protection Regulation (GDPR)

The new General Data Protection Regulation (GDPR) places certain limitations on the processing of personal data. In this sense, the qualities of blockchain technologies are in some ways incompatible with this regulation, as well as with Organic Law 3/2018 dated 5 December 2018 on the protection of personal data and the guarantee of digital rights. Specifically, the following stand out: citizens’ rights (e.g., right of erasure), since the information in a blockchain is inalterable, and this is one of the key features of how it works; the timeframes of conserving personal data, given that the data in blockchain are stored indefinitely; the principle of accuracy, because the data must be accurate and updated, and this could clash with inalterability, which is at the core of blockchain; and finally, the processing controller, since the GDPR stipulates that the processing controllers or co-controllers must be identified.

For all of these reasons, and given the questions that this technology raises, the legal aspects must be evaluated in advance (data protection regulation, primarily, as the legitimation for the processing and use of the data, art. 6 of the GRDP, data transfer, etc.) and the conclusions forwarded to the authorities that hold competences on this matter.

Likewise, bearing in mind that data covered in art. 9 of the GRDP may be processed, a risk analysis and impact evaluation must be conducted.
5. Conclusions

A large number of countries are beginning to develop blockchain technologies and DLT initiatives, most of them experimental, but the applications are progressing quickly and it is predicted that these technologies will enable new forms of organisation in socioeconomic matters and the governance of public services to be deployed in the near future.

Given their disruptive nature in terms of the potential for changing how society is organised, in a more notably decentralised fashion, without having to depend on the trust of an outside authority, this could become a revolution similar to the advent of the Internet.

Although it is true that the adoption of the Internet signalled a qualitative leap in terms of cultural, economic and social transformation, years after the onset of the 2.0 bubble we are facing a situation in which just a handful of agents control digital services around the world. This poses a risk stemming from the centralisation of these services, which makes them vulnerable to arbitrary criteria on access, censorship and/or security breaches and the protection of citizen data.

Given this centralisation and the risks it entails, it is somehow natural for this new kind of technology to emerge, which intrinsically operates through trust among peers without the need for intermediaries.

For this reason, having baseline knowledge and the capacity for technological development in this field is utterly crucial to successfully address Catalan society’s digital transformation process, as well as to become a country which has the capacities and aptitudes to compete in the new digital revolution.

Catalonia has capacities that make it a pole of attraction for technological deployment, services and new business models associated with blockchain technologies and DLT, and it has the potential to become an international benchmark in the development of this technology.

With this goal in mind, the government of Catalonia is promoting the Blockchain Strategy of Catalonia, through which it is carrying out a series of actions to support the deployment of blockchain technologies and DLT in Catalonia, organised around the following six strands:

- **Administration**: Improving public services through the adoption of blockchain technologies and DLT and making the government of Catalonia a pioneer in their application.

- **Promotion**: Positioning Catalonia as a benchmark in blockchain and DLT on the international tech map and disseminating the opportunities and impact generated by their deployment.

- **Innovation**: Promoting research and innovation through research and technology centres, and developing innovation environments to encourage their adoption in different sectors.
The Blockchain Strategy of Catalonia

- **Ecosystem**: Cultivating a new industry around blockchain technology and DLT and promoting the demand for services and solutions associated with top-priority vertical sectors
- **Talent**: Generating, retaining and attracting talent, both technological and entrepreneurial, with the knowledge and capacities needed to develop this new industry
- **Regulation**: Analysing the implications of the regulations on the deployment of this technology, as well as how to regulate the applications that use it.

The deployment of the Blockchain Strategy of Catalonia is the responsibility of the Ministry for Digital Policy and Public Administration, with the Secretariat for Digital Policy as the unit coordinating the strategy, in conjunction with the ministries of the government of Catalonia and the different agents in the blockchain and DLT ecosystem in Catalonia.