LAND BRANDENBURG

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Master Plan for the Cluster ICT, Media and Creative Industries

Berlin and Brandenburg

THE GERMAN CAPITAL REGION

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Master Plan for the Cluster ICT, Media and Creative Industries Berlin-Brandenburg

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Preface

The 2020 Master Plan of the Cluster ICT, Media and Creative Industries is the result of an interactive Cluster management process involving stakeholders and players from the fields of trade and industry, scientific research and administration. We would like to thank these players for their active participation.

The Cluster has seen much success and the world has undergone many changes since the first Master Plan was drawn up in 2015. You are holding the updated Master Plan in your hands at a time when the COVID-19 pandemic has unleashed enormous economic and social impacts within a period of only six months. Collection of topics and data for this document and the implementation of themed workshops and expert questionnaires largely took place prior to March 2020. To this extent, they have not been influenced by the subsequent events.

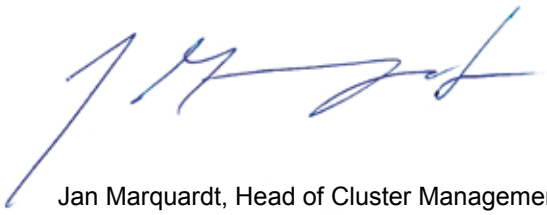
Innovation, digitalisation and creativity are all integral parts of the Cluster ICT, Media and Creative Industries. The COVID-9 pandemic means that greater attention is being directed to these three core elements once more. The creative industries, the events sector and many artists and freelance performers have had their livelihoods removed overnight. On the other hand, many start-ups and entrepreneurs who embraced digital innovation at an early stage have continued to display speed and agility throughout the crisis and in some cases have even tapped into new areas of business. Signs of overall economic recovery are emerging in the second half of 2020, and the hope would be that this will endure over the present Master Plan's period of validity.

The previous Master Plan provided a five-year basis for funding and the transfer of knowledge and technology. Five years is an eternity, particularly in the ICT Cluster area. Topics such as blockchain, artificial intelligence and other non-technical innovations have come along during this time. Although these are all familiar subjects today, they were virtually impossible to predict when the last Master Plan was developed.

The Cluster ICT, Media and Creative Industries is assuming an overarching and binding role between fields of application in respect of these and many other digitally instigated cross-cluster issues. For this reason, the Cluster sees itself as a driver of this development and is supporting, funding and assisting the opportunities which are arising from it. The premise we are following involves continuing to develop the excellence of the existing ecosystem, strengthening ongoing transfer of knowledge and making the results visible regionally, nationally and internationally.

Cluster management will work in conjunction with its players and use the Master Plan for the Cluster ICT, Media and Creative Industries to increase the radiance of the Berlin-Brandenburg economic region at a domestic and global level.

Amira Gutmann-Trieb, Head of Cluster Management



Jan Marquardt, Head of Cluster Management

Berlin/Potsdam, September 2020

The Master Plan at a glance

The Master Plan for the Cluster ICT, Media and Creative Industries is the **lead strategic document for the work undertaken by Cluster management** in close collaboration with the Berlin Senate Department for Economics, Energy and Public Enterprises, the Ministry of Economic Affairs, Labour and Energy of the State of Brandenburg and the players within the Cluster. It provides a framework and a joint work basis that offers the Cluster players targeted support and allows them to develop their competences further, to engage in networking and to participate.

The Cluster is portrayed together with the players it supports in **four content-oriented chapters** plus an annex, and a categorisation of the Master Plan is also undertaken. The fields of innovation, the issues forming an object of observation and integrative and cross-sectoral topics are all presented. This is followed by a description of the contribution being made by the Cluster to the guidelines and key focal points of the Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025).

The **first chapter** ("The Cluster ICT, Media and Creative Industries Berlin-Brandenburg") provides an overview of the self-conception and structure of the Cluster and explains the role of Cluster management. The digital and creative competences of the Cluster players, both in information and communication technology and within the media and the creative industries, enable them, and by extension the Cluster, to exert an effect across sectoral boundaries as **driving forces of digitalisation, innovation and creativity**. Within this process, Cluster management offers its support by acting as an innovation, transfer and economic development service provider at the interface between the groups of players.

In the **second chapter** ("The Master Plan"), the Master Plan is categorised in terms of the prevailing political, technological, economic and societal framework and with regard to developments. The tasks and objectives of the Master Plan are presented alongside the procedure for its updating.

Chapter three ("Fields of innovation") covers the **key focal points** of the Master Plan. This chapter principally describes the fields of innovation of the Cluster. It places these in a regional context, justifies their relevance for the region and lists the aims of Cluster management. The itemisation or stipulation of specific measures, projects or initiatives is not the intention or task of the Master Plan. Its emphasis instead is to offer the players a structural framework to develop their own projects, which in turn may be supported by the Cluster.

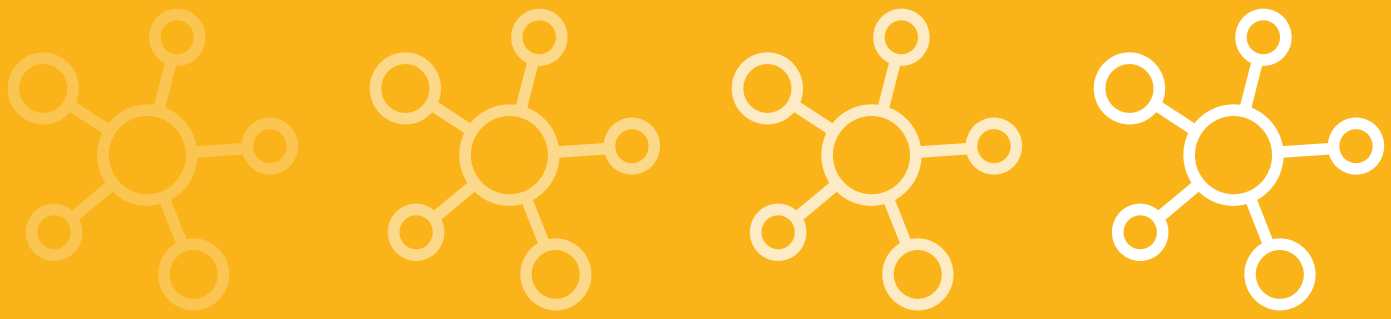
Alongside the fields of innovation which are enumerated in the section entitled **"Technology monitoring"**, further topics are also set out which, from today's perspective, will probably be of relevance to the region in future but which cannot thus far be specifically addressed within the scope of the fields of innovation. The final section of the chapter, "Overarching integrative and cross-sectoral topics", lists themes which are of equal importance to all players within the Cluster rather than being capable of attribution to a certain field of innovation or industry.

Fields of innovation	**Creation**	• The creative industries as an impetus provider • The media as a cosmos of information and experience • Open IT
	Processing	• Artificial intelligence (AI) • Platform economy • Big data
	Networking	• 5G applications and infrastructure • Internet of Things • Blockchain
	Use	• Extended reality (XR) • Geo IT • Information security and data privacy
Technology monitoring		• High-performance computing (HPC) • Quantum computing
Overarching integrative and cross-sectoral topics		• Prioritising sustainable innovations • Qualified workforce • Areas and locations • Smart city and smart country

The **fields of innovation** are subdivided into the **four main focus areas** of “Creation”, “Processing”, “Networking” and “Use”. The purpose of these categorisations is to provide structure, and they should not be interpreted as offering a clear-cut delineation. Both technical and non-technical innovation have been identified as fields of innovation within a participatively managed process. It is increasingly clear that players perceive innovations as being both of a technical type and of a non-technical, market-related social and societally oriented nature. The fields of innovation represent a targeted key focal point which maps the technical breadth of the Cluster and its players.

The **fourth** and final **chapter** (“Guidelines and key focal points of the Joint Innovation Strategy”) categorises the characteristics and contributions of the Cluster in accordance with the guidelines and main focuses set out in the Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025).

In light of the constant change facing the industries in the Cluster, which is frequently triggered by their innovative ideas, the Master Plan has been structured in a way which permits new developments to be addressed and predictable challenges to be countered.



1 The Cluster ICT, Media and Creative Industries Berlin-Brandenburg

1 The Cluster ICT, Media and Creative Industries Berlin-Brandenburg

1.1 Self-conception of the Cluster

The Cluster ICT, Media and Creative Industries in Berlin and Brandenburg forms a **platform for information, communication, networking and cooperation** between

- companies,
- scientific/research and educational institutions,
- chambers,
- networks and associations anpolicymakers in the form of the Berlin Senate Department for Economics, Energy and Public Enterprises, the Ministry of Economic Affairs, Labour and Energy of the State of Brandenburg and the economic development agencies of both states.

In its capacity as a supporter of economic development, the Cluster pools and fosters the **digital, media and creative potential** of players both within Berlin and Brandenburg and beyond the German capital region. The numerous technologies, applications, business models and methods which the players have in place and knowledge and competences stretching across sectoral boundaries enable them to use this potential to become driving forces for

- digitalisation,
- (technical and non-technical) innovation,
- creativity.

The Cluster acts to **encourage the transfer of knowledge and technology** between its players and across industries **(cross-cluster)**. Knowledge, experiences and new technologies and applications from the players in the cluster are deployed in a wide range of sectors and represent an important factor in terms of increasing overall economic effectiveness in the region. Innovations and services emerging from the Cluster are in demand from players in all industries. Collaboration and cooperation formats are just one of the vehicles via which the Cluster lends active support to transfer and networking.

In the Cluster ICT, Media and Creative Industries, innovation is more than just the result of research and development in the field of digital technologies and applications and also extends beyond the implementation and use of such R&D in a knowledge-enhancing way. The players see innovation as having a non-technical, market-related social and societally oriented character.

Indeed, **non-technical innovations** also certainly have their roots in technologies. Nevertheless, the primary contribution towards value creation stems from the ensuing novel product, service, process, organisational and marketing concepts and from the development of new business models. **Social innovations** are aligned to societal benefit because they are directed towards solving problems and challenges. Such innovations may, for example, involve new forms of social interaction, the sustainable use of resources or platform models for the joint exploitation of products or services.

Information, communication and media technologies are omnipresent nowadays and merge into one another virtually seamlessly. The opportunities afforded by the creation of new learning and experiential environments in areas such as extended reality have by no means been exhausted. They are, in fact, still in their infancy and are being put to successive use in various economic and scientific fields. In cross-sectoral terms, the services offered by the **creative industries** in the region constitute an important foundation for product, service, process, organisational and marketing concepts. In this case, the Cluster is supporting and promoting networking between providers and users.

Cluster management is assisting ICT, media and creative industry players in the initiation and successful execution of specific projects of both a technical and non-technical nature.

The **driving and acceleration of innovations** are not the sole point of significance of the work of the Cluster. It is also generating **visibility and understanding** of technical, non-technical and social innovations both within its boundaries and beyond and across other industries too.

1.2 Industry dimensions

The Cluster ICT, Media and Creative Industries was established as one of the five cross-cutting clusters within the scope of the Joint Innovation Strategy of the States of Berlin and Brandenburg[1] in order to strengthen economic and scientific expertise in the capital region in a targeted manner. Such an objective supports the players which operate along the value chains and within specific domains of knowledge and competence in

- information and communication technology,
- the media and
- the creative industries.

Figure 1 below provides a summary of the sectors and subsectors of the Cluster and highlights the **intersections of the industries** within the Cluster. The computer games industry, for example, makes use of digital tools from the ICT sector to create its products. It also, however, integrates elements from the media sector, which it links in a creative way to generate stories and scenarios. This cross-cutting aspect can be found in various sectors of the Cluster and demonstrates the close interlinking between industries and topics in the Cluster as a whole. Such a mixture of a broad spectrum of topics and narrow interlocking defines the particular character of the Cluster.

A further dimension of the Cluster is exhibited by a differentiation into **sectors which are primarily digital in nature and those which are either digitalised to a lesser degree or not at all**. Digitalisation has become an established tool over recent years and determines the way in which work takes place in almost every industry. It is also increasingly defining work processes, products and thus also patterns of (digital) thought, even if an end product continues to be largely analogue, such as a book or a work of art.

The combination of digitalisation and creativity is leading to innovations outside the Cluster industries and resulting in significant impetuses for application sectors in other clusters.

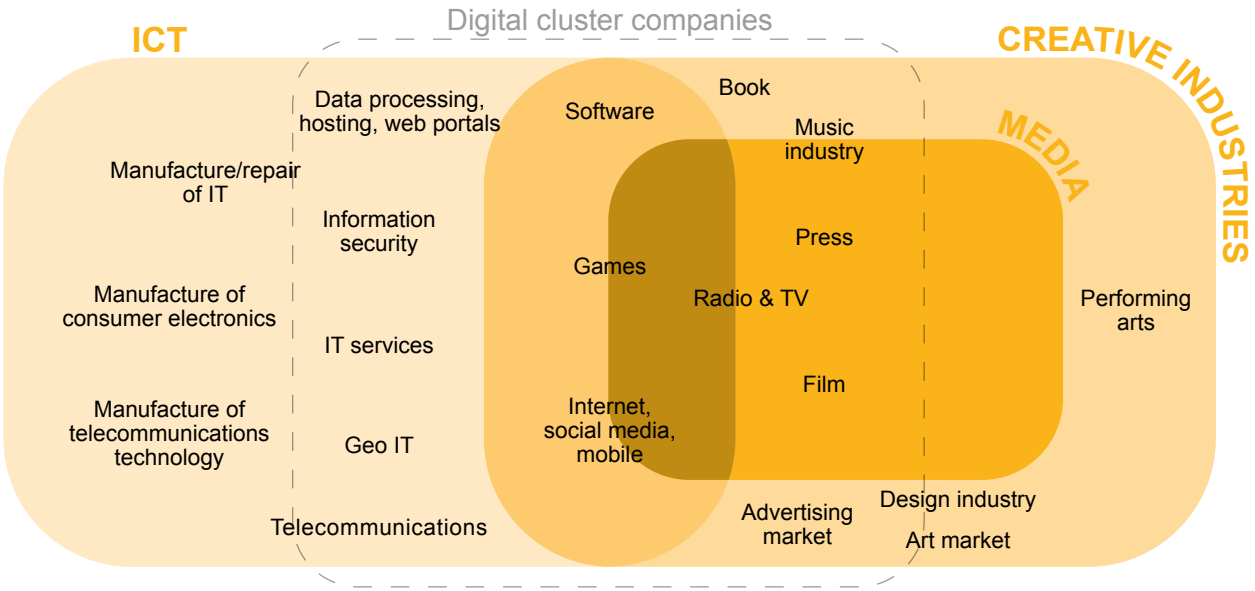


Fig. 1: Sectors and subsectors of the Cluster ICT, Media and Creative Industries

1 Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB) and its continuation “innoBB 2025”, which was launched in 2019. Information available online at: https://innobb.de/de/in-nobb-2025-eine-neue-strategie-fuer-neue-zeiten.

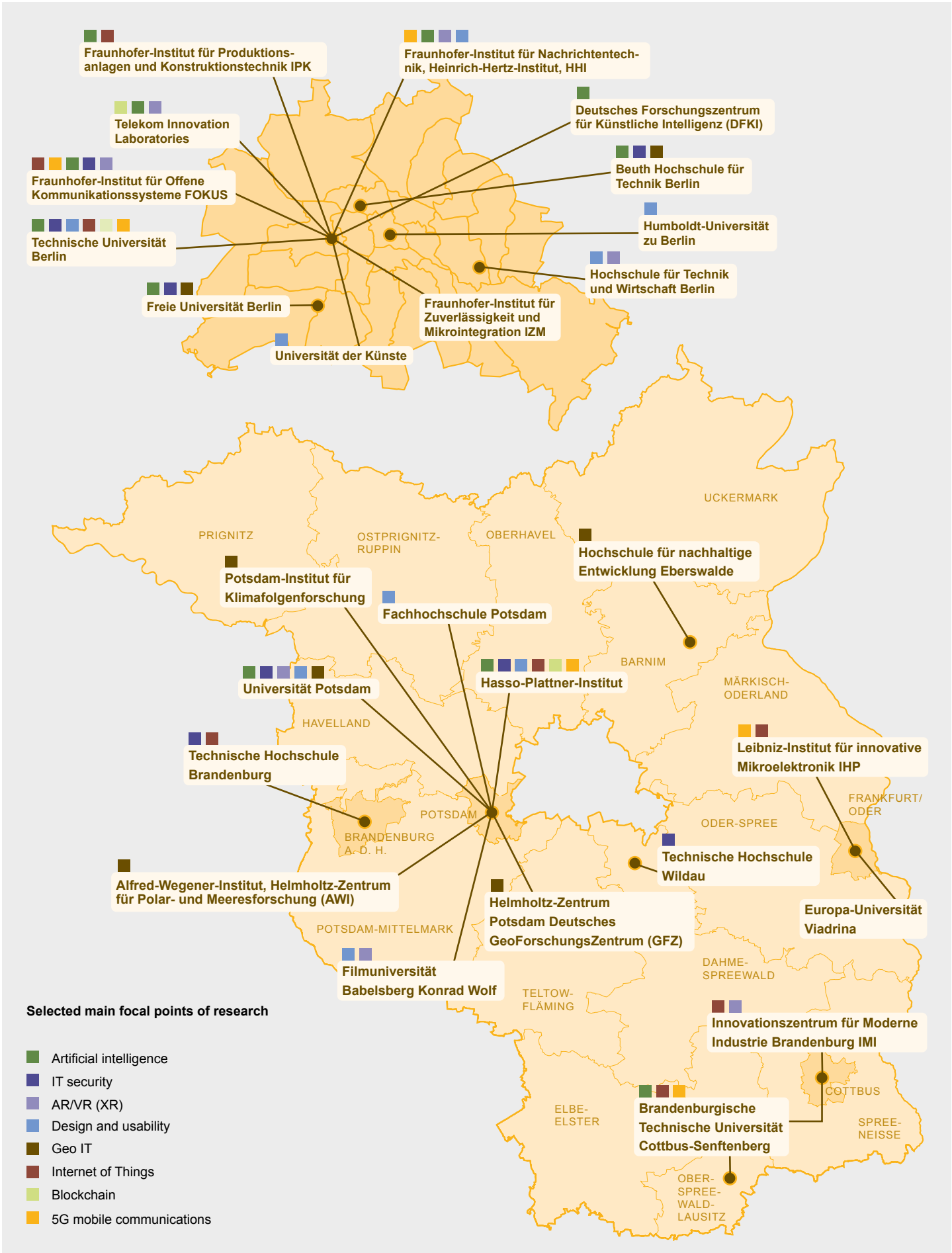


Fig. 2: Summary of higher education and extra-university research institutes of relevance to the Cluster in the region (focused extract) [representation by: i-vector]

1.3 Player structure in Berlin and Brandenburg

Scientific research

The Berlin-Brandenburg capital region has a multitude of higher education and extra-university research institutes which operate across a broad specialist spectrum with regard to the main focal points of the Cluster. Figure 2 provides a summary. Alongside those listed, there are various other institutes active in the region which have intersections to the main focal points of the Cluster. These cannot be itemised individually at this juncture.

Economy

The Cluster is characterised by a heterogeneous company structure and consists of a broad range of companies. Architecture, software providers and games are all represented. There is also a multifarious start-up scene, which includes FinTech (financial services), LegalTech (legal services) and PropTech (real estate services) companies.

Both the chambers of commerce and industry and the chambers of crafts and trades in the region provide central representation and lend active support to these companies by offering a wide range of services and events.

The summary of the industries within the Cluster underlines its diversity.

Industries represented in the Cluster

- Architecture market
- Book market
- Performing arts
- Design industry
- Film industry
- Information and communication technology
- Art market
- Music industry
- Press market
- Broadcasting industry
- Software/games
- Advertising

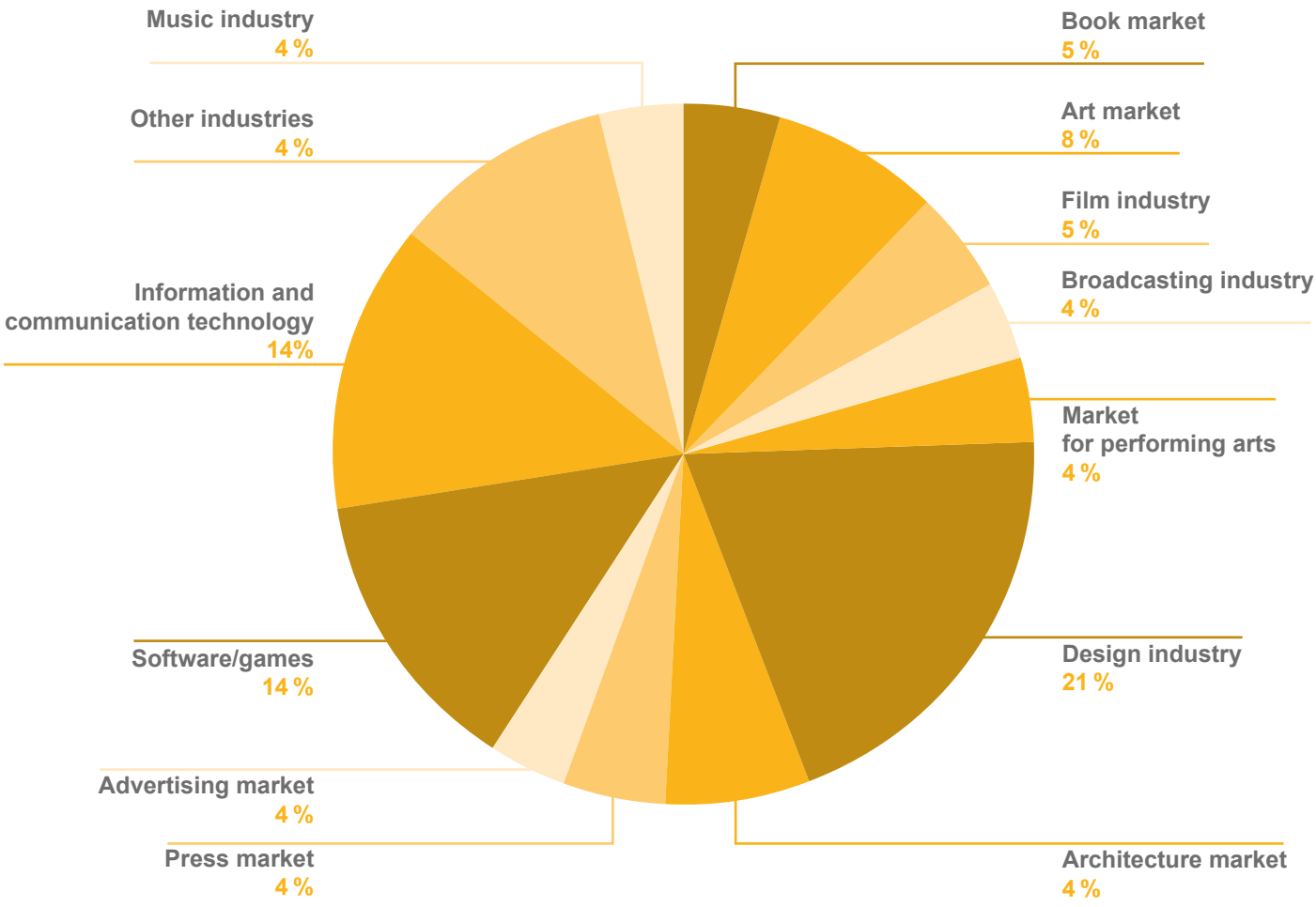


Fig. 3: Proportion of industries in the Cluster in 2017 relating to number of companies [representation by: i-vector; data source: Cluster Monitoring]

The design industry accounts for 21% of companies in the Cluster and thus makes up its largest proportion. It is followed by information and communication technology and software/games, each of which makes up 14% of the Cluster companies.

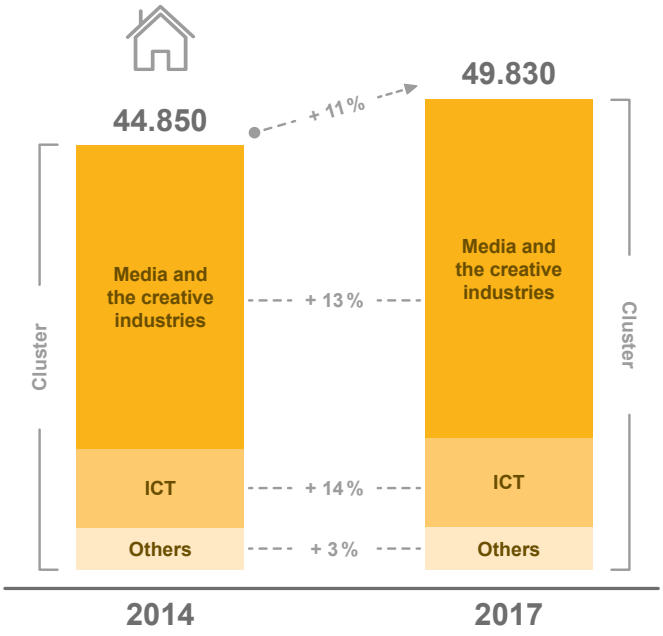


Fig. 4: Development of the number of companies in the Cluster from 2014 to 2017 [representation by: i-vector; data source: Cluster Monitoring]

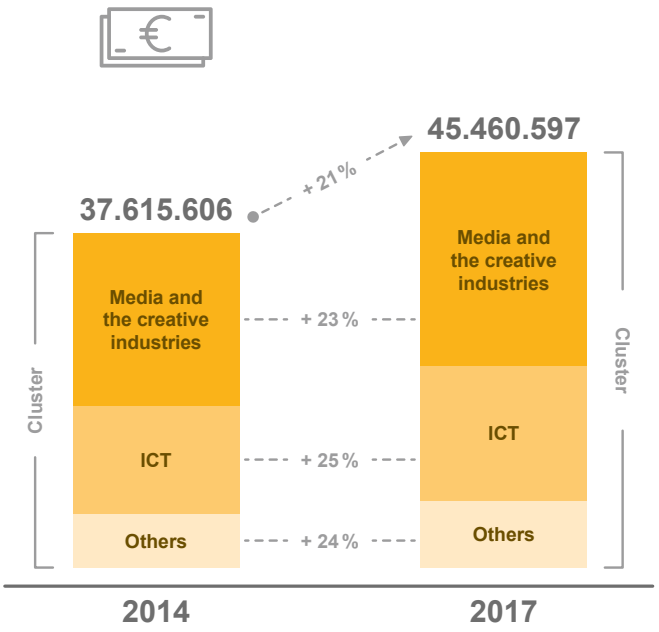


Fig. 5: Development of turnover of Cluster companies from 2014 to 2017 [representation by: i-vector; data source: Cluster Monitoring]

The development of companies in the Cluster since publication of the first Master Plan may be viewed as having been very positive. Around 5,000 companies (11%) have joined the Cluster since 2014. The Cluster ICT, Media and Creative Industries consists of just under 50,000 companies and is the biggest cluster in the capital region.[2]

The number of companies is not the only aspect which has seen a positive development over recent years. Turnover has also risen. Viewed across the whole of the Cluster, companies recorded a growth in sales of around 21% (from 2014 to 2017). The differences between the industries in the Cluster are marginal.

The number of employees subject to mandatory social insurance contributions has also developed positively over the past few years. An increase of around 24% took place between 2014 and 2018. This means that more than 50,000 additional persons found a job at a company in the Cluster in 2018 as compared to 2014.

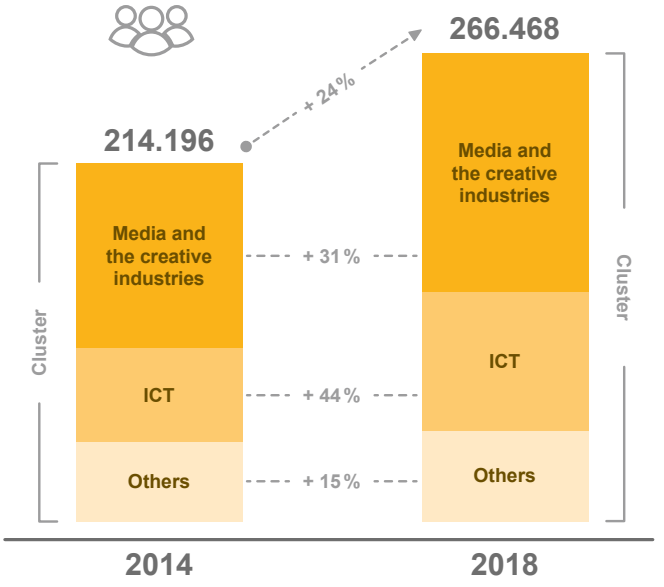


Fig. 6: Development of employees subject to mandatory social insurance contributions from 2014 to 2018 [representation by: i-vector; data source: Cluster Monitoring]

2 The values listed here are not comparable with figures issued by other bodies because a different counting method is used.

Associations, networks and initiatives

The players and topics of the Cluster are represented and supported by a multitude of regional associations, networks and initiatives. The figure presented below provides a summary. Players are categorised according to their alignment (industry or topic related).

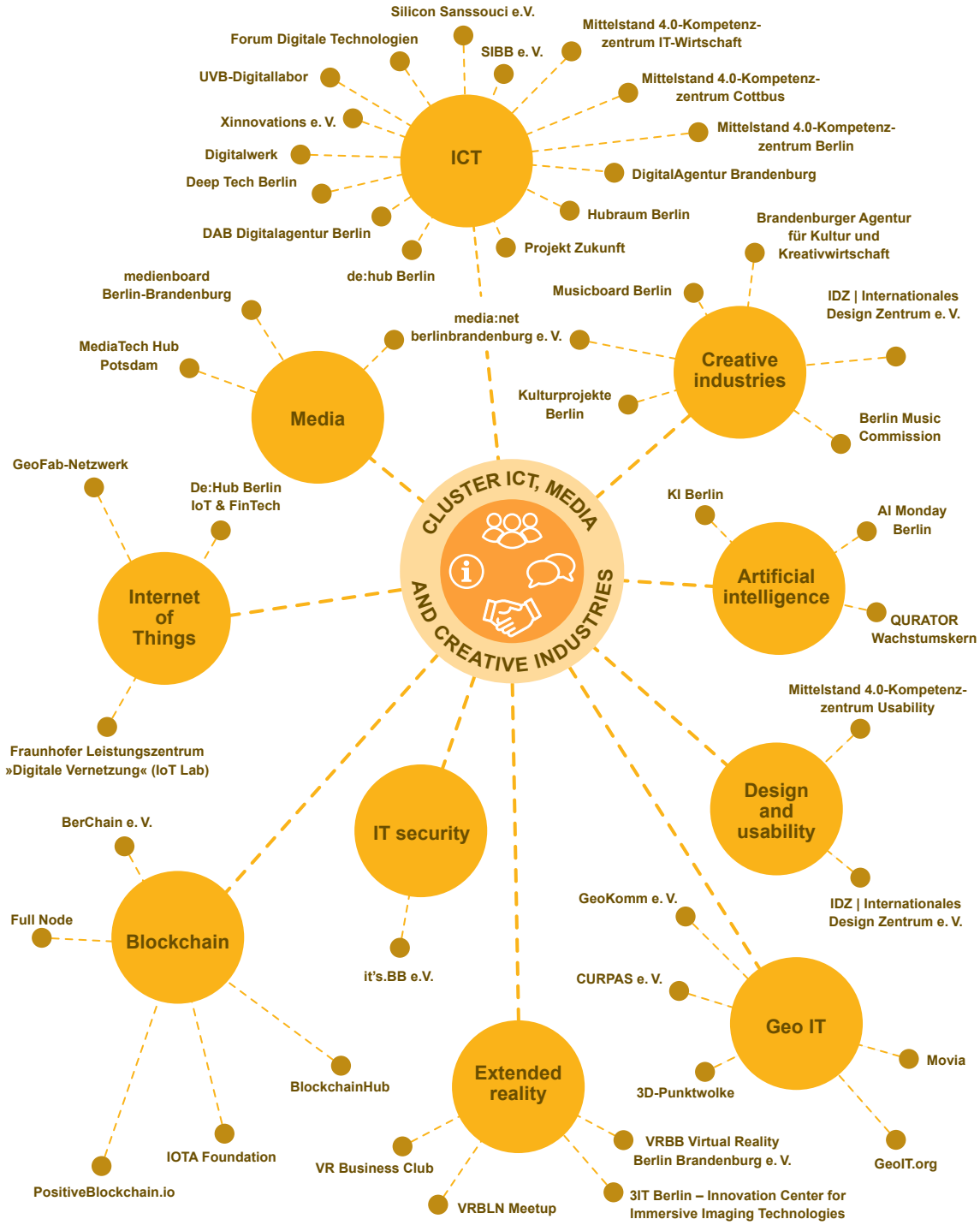


Fig. 7: Selection of regional associations, networks and initiatives of relevance to the Cluster

1.4 Role of Cluster management

The activities of the Cluster are supported by closely interlinked work carried out within the scope of a **cross-state Cluster management system**, which is jointly provided by the economic development agencies of Berlin and Brandenburg and led by two Heads of Cluster Management.

Cluster management offers its **support by acting as an innovation, transfer and economic development service provider** for the ICT, media and creative industries players in Berlin and Brandenburg which receive assistance from the Cluster.

In its role as an **interface between the groups of players** in the Cluster, Cluster management acts as an internal and external guide and trailblazer with the goal of securing and further developing the innovation and competitiveness of the regional economy. Its tasks in this regard include the following:

- Networking companies with scientific research institutes for the purpose of the transfer of knowledge, competence and technology
- Support with initiation of projects in accordance with the fields of innovation
- Networking the players in the Cluster with one another and with players in regional (applied) industries and also with stakeholders operating at a national and international level
- Expansion of the visibility of the competences available at the location via targeted Cluster marketing with the aim of acquiring new transfer partners
- Implementation of own events and support for external events
- Monitoring and evaluation of technological developments

Focus and cooperation

The large number of industries in the Cluster and the resultant diversity of the topics addressed in the fields of innovation create major requirements for Cluster management and for the administrative bodies of the federal states in terms of deploying available resources and capacities in a focused way. For this reason, the emphasis needs to be on setting **a smart key focal point**. Cluster management therefore concentrates its work on the topics which can be expected to deliver the greatest effect on economic development in the region. Nevertheless, it also provides support for topics to which this premise does not apply.

Cooperation based on the principle of division of labour takes place with the industry-related or topic-oriented networks and task-specific initiatives that are active in the region. This collaborative approach enables the development of topics which are important to the players to be driven forward in an efficient and targeted way to deliver a joint benefit. In addition to this, focused cooperation is also pursued with further domestic and international players.

2 The Master Plan

2 The Master Plan

The Master Plan is the lead strategic document for the work undertaken by Cluster management in close collaboration with the Berlin Senate Department for Economics, Energy and Public Enterprises, the Ministry of Economic Affairs, Labour and Energy of the State of Brandenburg and the players within the Cluster ICT, Media and Creative Industries. It reflects the framework which applies to the players in the Cluster by providing appropriate, directional suggestions for structure and focus and for the joint work.

2.1 Framework

Master Plans for clusters are not an end in themselves. Their aim is to serve as a "blueprint" and indicatory template for players in the region so that more can be achieved via joint endeavour – more added value, higher employment, greater knowledge and more innovations.

In order to accomplish this, the Master Plan addresses the **needs of the companies and of the scientific research stakeholders** in the region. The political, technological, economic and social **framework and developments** exerting an effect on the players in the Cluster are also of significance in this regard. The Master Plan incorporates these factors so that it can act as a **strategic working document** which offers guidance and support.

Requirements and technological, economic and social developments are reflected in the choice of topics in the fields of innovation, which has been specified and set out in detail via the involvement of numerous regional players.

Strategic incorporation of the Master Plan
As well as having its structure determined by the requirements which emerge from within the Cluster, the Master Plan is also aligned to central strategic documents at a regional, national and European level. The updated **Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025)**, which was adopted in January 2019, forms an essential foundation. Its guidelines and key focal points contain directional stipulations for the way in which the priorities of the clusters and their Master Plans are laid out.

The key focal points of innoBB 2025 are as follows:

- Digitalisation
- Real-world laboratories and test fields
- Work 4.0 and a qualified workforce
- Start-ups and new businesses

The **digital policy strategies** of the State of Brandenburg (2018), of the State of Berlin (under development) and of the Federal Government ("Digital Strategy") and the **industrial policy strategies of the federal states** – "Master Plan Industrial City Berlin" and "Guidelines for Industrial Policy in Brandenburg" – are of core relevance to the Cluster ICT, Media and Creative Industries. The "Shaping Europe's Digital Future" Strategy, which was adopted by the European Commission in February 2020, is a key document at a European level. The "High-Tech Strategy 2025", which was initiated by the Federal Ministry of Education and Research in September 2018, ties in with the above by forming a **technology-oriented strategy** aimed at target development of the technologies underlying the products and applications of the Cluster players. Further programmes are being derived from the latter.

The "Real-World Laboratories as Test Beds for Innovation and Regulation Strategy", which was launched by the Federal Ministry for Economic Affairs and Energy in 2018, is one of the starting links for the **key focal point** of **"Real-world laboratories and test fields"** contained within the innoBB 2025.

The topic of **sustainability** has gained greater attention in the areas of society, policymaking and the economy over recent years and thus has also become an increasing focus of the Cluster. The Federal Government is using its "National Sustainable Development Strategy" (October 2018) to place a policy emphasis on this issue, and this is also something which is being addressed by the European Commission via the "European Green Deal" (January 2020).

The **strategies and programmes** listed below, which are predominantly **technology-specific** in nature, are also exerting an influence on the structure of the Master Plan and on the work of the Cluster:

- Artificial Intelligence Strategy of the Federal Government (2018)
- Strategic Framework "Artificial Intelligence for Europe" (2018)
- White Paper on Artificial Intelligence from the European Commission (2020)
- 5G Strategy for Germany (2017)
- Cyber Security Strategy of the Federal Ministry of the Interior (2016)
- Quantum Technologies Framework Programme of the Federal Ministry of Education and Research (2018)
- Blockchain Strategy of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Finance (2019)
- European Data Strategy of the European Commission (2020)

2.2 Task and objective

The Master Plan should be viewed as a **strategic foundation for the tasks of the Cluster** over the coming years and has an impact on **cooperation** between the Cluster players. The primary function of the Master Plan is therefore to **create a joint work basis** which reflects the main thematic focuses of the regional innovation landscape in ICT, media and the creative industries and also takes account of the needs of the application sectors for digital, media and creative services.

The goal is to provide Cluster players from trade and industry and in the field of scientific research with targeted support in **further developing, networking and deploying their competences**.

The intention is that the Master Plan should set out key directions of travel which will enable the Cluster as a whole and in particular the work it undertakes to be driven forward on an ongoing basis and in a way which is in line with requirements.

The fields of innovation in the four main focus areas[3]

- **Creation,**
- **Processing,**
- **Networking** and
- **Use,**

the cross-cutting topics and the topics[4] forming an object of monitoring[5] have been **specified in a balanced way** for many of the players.

In light of the rapid manner in which technological circumstances are developing and changing and given the agility of the markets and the emergence of a new policy framework, the Master Plan cannot be seen as a document which will remain rigid over a period of years. It needs to stay alive within the framework imposed by the fields of innovation in order to be able to supply strategic responses to new challenges when necessary. For this reason, Cluster management also faces the task of addressing developments as new topics emerge in future years.

However, the itemisation or stipulation of specific measures, projects or initiatives is not the intention or remit of the Master Plan. Its emphasis instead is to offer the players a structural framework to develop their own projects, which in turn may be supported by the Cluster. In addition to this, the Master Plan is of relevance to decisions regarding the awarding of regional innovation funding.

3 See Chapter 3.1 to 3.4.
4 See Chapter 3.6.
5 See Chapter 3.5.

2.3 Updating process

The first Master Plan of the Cluster was published in 2015. This initial plan has marked out Cluster management work conducted over the past five years. In some cases, rapid and comprehensive changes on the market and to technologies, applications, business models and distribution channels have occurred since its publication. The strategic framework at a regional, national and European level has also undergone further development in line with the respective requirements and objectives.

Against this background, the process of updating the Master Plan commenced at the start of October 2019.

Amendment process
The guiding motif for structuring the amendment process was to adopt a robustly participative approach towards its implementation. For this reason, emphasis was placed on providing various formats to enable the different industries and groups of players constituting the Cluster to become involved in the procedure and to bring their wishes and requirements to bear.

Desk research: Initial research was conducted to evaluate relevant political strategies, studies and scientific publications within the context of the Cluster. A supplementary text mining process was carried out to assess scientific research publications relating to ICT. The information collected served as a foundation for the derivation of trends, focus topics and main framework conditions for the three Cluster areas. These results provided a discussion basis for the following participatively aligned formats which were conducted in parallel.

Interviews: Interviews were held with specialists from companies, with scientific experts, with intermediaries and with representatives from the regional clusters in order to request appraisals of the topics previously collected.

Online survey: An online survey afforded players within the Cluster an opportunity to evaluate, comment on and add to the topics which are relevant to them and to their work today or which may gain in significance in the coming years.

Workshops: The findings from the interviews and the online survey were used to stage two workshops involving selected experts. The first of these concentrated on future topics for the ICT industry, whilst the second looked at forthcoming issues for the media and the creative industries. One aspect included in each workshop was a discussion of eight topics which had been deemed particularly relevant beforehand.

The following topics were discussed in the media and creative industries workshop:

- Augmented reality/virtual reality
- Games
- Content creation
- Media distribution
- User experience
- The creative industries as an impetus provider
- Sustainability
- New worlds of work

The main topics of the ICT workshop were as follows:

- Artificial intelligence
- Blockchain
- 5G
- Internet of Things
- IT security and privacy
- Geo IT
- Sustainability
- New worlds of work

As well as the organisation of two workshops as part of the Master Plan process, there was also an opportunity to become actively involved in committees of the chambers of commerce and industry in Berlin and Potsdam (Berlin: Creative Industries, Digital Economy and Innovation & Technology; Potsdam: ICT). Within the scope of the committees, the Master Plan process was explained, and contributions made by participants were recorded.

Writing the Master Plan: The findings acquired via the previous stages were written up for inclusion in the Master Plan.

Coordination: The Master Plan was coordinated with the involvement of the main Cluster stakeholders, the experts who had been interviewed and the workshop participants.

Publication: The Master Plan finally entered into force upon publication.

Further development: New topics may gain in relevance for the Cluster players over the course of the coming years. These will need to be evaluated and addressed as necessary in order to continue to develop the content of the Master Plan. For this reason, the Master Plan has been designed to be flexible. A further intention is to establish a committee structure. The aim is for the committees to provide Cluster management with thematic guidance and to make proposals as to how the content of the Master Plan can be supplemented.

3 Fields of innovation

3 Fields of innovation

The breadth of the task areas offers the potential to draw up a large number of fields of innovation containing countless topics of relevance. Processing and driving this process forward in an appropriate way whilst keeping the Cluster players on board represents a challenge. For this reason, useful and **targeted priorities** have been chosen based on specific regional circumstances.

The structural focus areas of

- **Creation,**
- **Processing,**
- **Networking** and
- **Use**

will address the fields of innovation which, according to the present state of knowledge, offer the most (innovation) potential for the Cluster areas as well as for the application sectors. When structuring the fields of innovation, care was taken to accord equal treatment to technical and non-technical topics relating to the areas of digital, media and the creative industries. Nevertheless, the selection of topics also needs to accord due consideration to the urgent requirements regarding digitalisation which are emerging both from within and outside the Cluster.

Figure 8 below acts as an index of contents by providing an overview of the fields of innovation. The four focus areas listed provide structure to the fields of innovation without undertaking a clear-cut delineation.

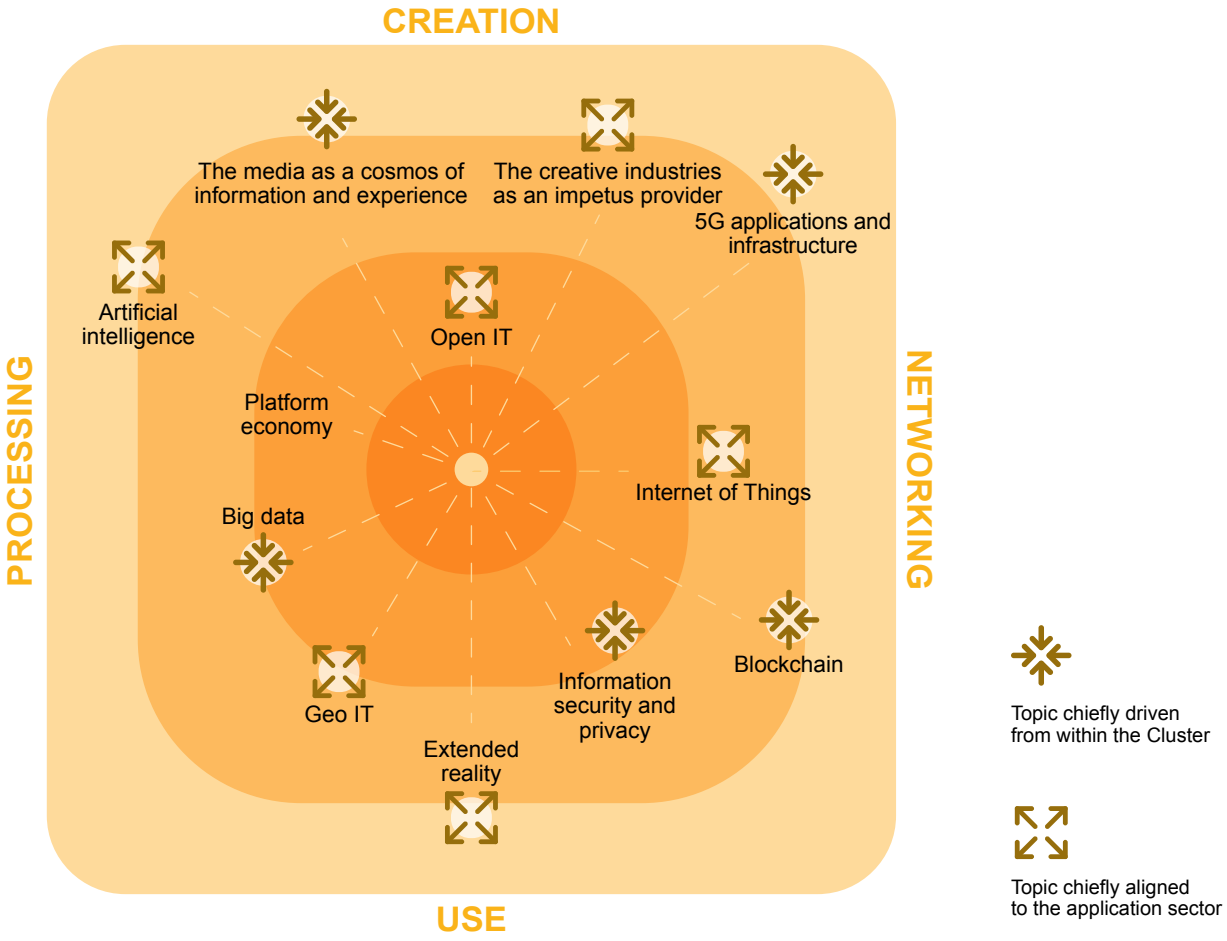


Fig. 8: Overview of the focus areas and fields of innovation [representation by: i-vector]

3.1 Focus: Creation

The creative industries as an impetus provider

Main innovation topics

User experience design	Sustainable design	Design thinking	Gamification
Fashion tech	Advertising	Communication	Fashion industry
Sustainable fashion	Upcycling	Wearables	Digital storytelling
Digital art and culture market			

The "Creation" focus area pools the fields of innovation which concentrate on the development of new digital, media and generally creatively designed products, applications and contents.

The fields of innovation denoted as **"The creative industries as an impetus provider"** and **"The media as a cosmos of information and experience"** deal with the deployment of creative services and methods, whilst **"Open IT"** is concerned with the free availability and use of knowledge, data and technologies.

Creativity is an essential foundation for innovations alongside technological excellence and an instinct for the market. The multifarious players within the creative industries are able to draw up solutions for existing problems by pursuing pathways not previously considered. They need to be viewed as **overall economic drivers of cross-sectoral innovations** rather than merely being perceived as suppliers of "beautiful things". If impetuses are taken up by trade and industry, this also provides an opportunity for us to **learn from one another** to our mutual benefit.

New products, applications and services and companies as a whole nowadays need to take **comprehensive requirements** into account in order to achieve success on the market. Products should not solely fulfil their expected functions. They need to offer new functionality on a constant basis, be capable of intuitive use and fulfil stricter ecological requirements. Digitalisation is associated both with a **change of use** with regard to the products and services and with a cultural shift at companies (Work 4.0).

One methodologically shaped part of the service provision of the creative industries is **user experience design (UX)**. The focus here is on structuring the experience and feeling of a person in relation to a product, a service or an online offer. In order to achieve this, there is a need for tried-and-tested scientific methods which can be used to analyse the processes, products and types of behaviour of users and thus establish a basis to offer guidance and support and to improve usability. Especially in times of advancing and extensive digitalisation, new possibilities arise for structuring the experience of the customer in a comprehensive way. This also involves marking out the experience of the customer with regard to various aspects of a product or service by embedding the process into a rounded and interesting story, e.g. via digital storytelling.

Design thinking is both a multidisciplinary creativity methodology and a methodological approach which aims to shape corporate culture, especially within the scope of the influence of changes being brought about by digitalisation. The factors of team, space and process are at the heart of the methodology. It addresses the question of the constellation which cooperation might assume in future, on where this work can best take place and how processes of collaboration can be structured in the most effective way.

Sustainability is gaining in social significance. **Sustainable design** is one means via which the creative industries are offering a methodological approach which enables the sustainability of a product to be influenced at an early stage of the development process by undertaking design measures. This does not merely involve the application of concepts which lead to a reduction in the use of resources. Recycling and later upcycling of the products are also addressed.

Sustainability is also becoming more and more important in the **fashion industry**. The fashion players in the region take account of sustainable fashion at an early stage by adopting a circular design approach during the concept phase. The emphasis is placed on materials that have been sourced and manufactured by sustainable means, and consideration is also given to the durability and to the reuse or recycling of clothing. Reuse can, for example, be achieved via second-hand sales. Clothing may also be returned to retailers for recycling, whilst upcycling also takes place (creating new products from old products).

Fashion tech, i.e. a combination of fashion and technology, is also a core topic in the fashion industry. The deployment of a wide range of technologies opens up new pathways for design and distribution and for the creation of unique customer experiences. Technology can, for example, be integrated into garments in order to provide clothing with enhanced functionality (wearables). The genesis of fashion can also be influenced by technology, for instance via the use of artificial intelligence in the design phase. In sales, augmented/virtual reality systems enable clothes to be tried on virtually.

The new digital channels are gaining in influence at **advertising and communication agencies**. Digital communication and promotion have now become an important component of campaigns. Online or mobile online advertising (for mobile end devices) and advertising via social media are likewise growing. The benefit and impact of online advertising are explored via mobile insights and analytics, which go on to influence the way in which advertising concepts are structured. Communication and advertising also make use of methods such as digital storytelling (see the field of innovation “The media as a cosmos of information and experience”) in order to make campaigns more accessible and more readily perceptible. Technologies such as augmented and virtual reality will provide further channels for advertising and communication agencies in the future.

The visibility and experiential tangibility of services and provision are a key economic success factor for the **art and culture market in the region**, which is primarily represented by creative artists and distributors, suppliers and service providers, book and music publishers, online portals, events and PR agencies and the many music, dance and theatre venues. The presence of art, which was previously largely analogue, is being supplemented by new digital forms of representation and preparation. Digital offerings such as exhibitions, guided tours, concerts, readings or art-related online platforms enable art and culture to be presented to potential customers via fresh channels and thus improve visibility. Non-technical innovations in the field of art and culture are also playing an ever larger role for the creation of added value in the region. Such innovations may involve product developers in the tourism branch, content producers for the media, software and games industry, catalysts for the design economy, for industrial and urban development and for the conquering of rural areas (smart country) and, last but not least, a location asset for competition between regions.

Relevance and potential for the region

The spectrum of creative minds in the region is broad. There are designers, fashion companies, advertisers, architects, art and culture professionals and a whole host of other creative players of various backgrounds and disciplines. Within the scope of the interdisciplinary cooperation which takes place, they are able to generate new impetuses for the thought processes, work and design ideas which inform new products and services.

Objectives of Cluster management

- Strengthen the cross-cutting visibility of the creative industries and the contribution they make to innovations, e.g. via closer integration into intersectoral events formats
- Foster networking and cooperation between creative artists and other economic representatives, such as in special interactive types of event
- Strengthen awareness of the topics and contributions of the creative industries, for instance to support sustainability and the cultural shift and to adapt to user needs

The media as a cosmos of information and experience

Main innovation topics

Media streaming	VR/AR media experience	Sensing media	Sustainability
Volumetric videos	Digital visual effects	Digital media distribution	Media use research
Digital music distribution	Digital journalism	Data journalism	Data visualisation
Digital press marketing	Games streaming	Blockchain	Artificial intelligence
Digital storytelling			

The capital region boasts an extensive and diverse **film and broadcasting industry** which enjoys international appeal. The streaming of films, videos, music and podcasts has become an important form of media distribution within the industry alongside established channels. The technologies and workflows which are necessary in this regard need to be developed further in line with the requirements of these channels.

New possibilities are also emerging in terms of content. New ways of preparing content are being created as **VR and AR technologies** continue to be developed. This is generating fresh experiential opportunities for film creators and media consumers alike.

Volumetric videos offer a further new way of designing media contents. This technique involves digitalising persons via the use of several cameras so that they can be integrated into various multidimensional environments and stories. Methods and tools for the generation of digital visual effects (VFX) are also being constantly driven by technological development. Effects are becoming more comprehensive, more detailed and more realistic on an ongoing basis. As well as focusing on further technological developments relating to new contents, the industry is also addressing the implementation of **sustainability**. Various pathways are being pursued in this regard. One objective, for example, is to design film sets in a more sustainable way.

The **music industry** in the capital region is characterised by a wide range of diversity which encompasses musicians, composers, recording studios, labels, publishing houses, event organisers and clubs. Music is created, played and distributed worldwide. Digital technologies are becoming an increasingly important part of creative performance.

The various providers are seeing an increase in the significance of music streaming as a distribution channel. This follows the general trend towards a platform economy for music distribution. New digital methods to support creative artists are being trialled in the composition of musical pieces. Software systems, for example, are able to use artificial intelligence methods to help with the compilation sequences of sounds. Possibilities of using **blockchain technology** are also under consideration. There could be options to deploy this for the processing of various payments models or for the secure traceability of rights.

The **games industry** is held to be a pioneer in the use of digital technologies. The number of games in which **virtual and augmented reality systems** are being deployed is on the increase. New technical and narrative opportunities for delivering a more intensive and more comprehensive game experience are emerging, and these may also appeal to new customer groups. The technical possibilities offered by artificial intelligence to create even more detailed automatically generated worlds or better non-player figures could also enrich the games themselves. Better analytical methods will enable them to be adapted to customer preferences in a still more individual manner.

Acquisition and consumption of games predominantly takes place online (e.g. e-sports). Various providers enable games to take place via streaming in a way which is largely detached from their own technical prerequisites. As playing becomes more important, watching games is also growing in significance. Action from various games is broadcast live. This has now resulted in a further marketing channel for the games industry.

Blockchain technology may be able to create transparency in the games industry in future by establishing new payment models or reward systems for gamers.

Companies on the **book and press market** experienced the impacts of digitalisation at an early stage. Over the past few years, they have adjusted their processes and business models to the new facts and circumstances are taking advantage of the opportunities afforded to them by digitalisation. Cross-platform or platform-specific **digital journalism**, i.e. preparation of material that is adapted in terms of content and design, is making great strides. **Digital press marketing** is expanding alongside print sales. New payment models and sources of revenue are emerging. But new forms of presenting content are also appearing, for example through greater proximity to readers. Such proximity is achieved via vehicles such as programmatic publishing, which uses data analysis to adjust contents to the preferences of users. Data is generally taking on an ever greater role. One field in which this can be seen is in so-called **data journalism**, which involves the collection, preparation and vivid visualisation of large quantities of data relating to specific thematic areas.

Players on the book market are also increasingly deploying digital technologies. Digital books have long since been available alongside printed versions. Books are digitally prepared in the background for publication on various platforms and in databases. **Artificial intelligence** provides targeted summaries which help create clarity in publication lists with the particular aim of offering academic and scientific researchers an opportunity to remain up to date. The use of **blockchain technology** can also assist in achieving such an overview. One use case is the transparent representation of rights to research images, something which is of particular relevance to specialist academic and scientific publishing houses. New opportunities are also being made available to readers, e.g. via the use of AR/VR technologies to enhancing the reading experience.

Digital storytelling: Communication, the contents of communication and all the various facets of stories relating to aspects such as a new product, a service or a company as a whole still frequently follow a traditional, linear and static pattern, including online. Although complex products or topics such as the energy transition, innovative business models or new designs can be presented in this fashion, such depictions are not always made sufficiently clear and comprehensible for every user group.

Another route already being pursued by various players, especially those with a digital affinity, is described using the term “digital storytelling”. The focus here is on how, in a digitally shaped environment, stories and their contents can be imparted in a new way which takes account of the perspectives of integration, availability, networking and interactivity. The numerous digital channels offer multifarious elemental means of reaching target groups more precisely via person-specific and platform-specific formats, of interacting with the target groups and of measuring their response, so as to be able to curate the content accordingly and embark on a change of direction.

For this reason, **telling stories in digital environments so that they are heard, seen and understood** requires both creativity and digital expertise.

Integration of content for different types of devices, platforms and applications is a fundamental dimension of digital storytelling, and this is a suitable way of ensuring a seamless shift between the media. Consideration therefore needs to be accorded to availability at all times and in various situations. This also enables context-based contents to reflect the requirements of users. Preparation and networking of different media formats such as text, images, sound and video represents a further dimension. There may, however, be other contents which are available via augmented reality systems and which extend the story into the real environment. Finally, there is the added dimension of personal or agent-based communication with the users, in other words a feedback channel, via which interaction with the users can take place.

Relevance and potential for the region

The output of the media industry in the region is highly varied and constantly alters as changes take place to devices, platforms or general possibilities of technical preparation. Stories are drafted and related, facts are researched and processed, and people are informed and entertained. The media industry forms a unique cosmos of information and experience. The

opportunities offered by digitalisation allows media players to create new formats which offer new quality and are prepared in a new way.

Alongside the large number of established companies and freelancers, young and agile start-ups with media and digital affinity are making a mark with their own ideas, formats and technologies in order to make complex facts and circumstances communicable. Networking is what is required – networking within and between the digital, media and creative industries for the purpose of development and implementation of new technologies and services.

Objectives of Cluster management

- Present benefits, applications and challenges of digitalisation in the media
- Network players and potential users of services in the media industry
- Strengthen awareness of media players as creative drivers with a digital affinity

Open IT

Main innovation topics

Open Source	Open Access	Open standards	Open interfaces
Open hardware	Open protocols	Open data	Open file formats

Open IT is a collective term which encompasses various aspects of an ecosystem which is aligned towards free availability and use. It applies in particular to

- open data,
- Open Access and
- open standards.

Open data describes a holistic concept which states that machine-readable and structured information may be used, reused or disseminated by anyone via the use of open licences. Data to be published in accordance with the open data principle must not contain personal information or general data which is subject to privacy law or which discloses company or business secrets. The aim of open data is to use existing data, including in combination with various data sources and data sets, to generate added value for the economy, for academic and scientific research, for government administration and for the general populace. Open data may originate from government authorities (e.g. geodata) and publicly owned companies (e.g. public transport), from private sector companies or from scientific institutions. It also includes information donated by private persons for a specific purpose, such as medical research. Some of the criteria for the provision of open data are quality of data, open licences for non-commercial reuse and interoperability of the data, non-discriminatory access and the use of open standards. The types of data which may potentially be suitable for free use are as extensive as the application purposes. Traffic information may, for instance, lead to the development of new mobility services. Medical research results can facilitate new or improved treatment methods.

Open Access relates to the free availability and use of academic and scientific research literature, of research results and of cultural data. The usual practice up until now has been to publish research results in specialist scientific or academic magazines or journals, even if such results have been

achieved via public financing. The aim of Open Access is that results of academic or scientific research conducted by other researchers should be made available to trade and industry and to members of the general public who are interested. The intention is for the free accessibility of scientific and academic research findings to facilitate new impetuses for innovation both in the scientific community and in the private sector economy. Open Access to cultural data expands the perspective to the multifarious cultural identities of the region. The objective of the Open Access strategies of the States of Berlin and Brandenburg is to create free accessibility and comprehensive Open Access usability in the areas of "scientific publications", "research data" and "cultural heritage/cultural data".

"Open standards" is a term which encapsulates the challenges of Open Source, the topics addressed within this context, which include open source software and hardware, and further relevant issues such as open interfaces, protocols and file formats.

Relevance and potential for the region

Open Access to data and scientific findings and the availability of open standards may enable the scientific and academic research communities to arrive at additional results, permit trade and industry to develop new business models and innovations or lead to an improvement of existing services. As far as the general populace is concerned, this may mean that research results are created and be applied more quickly. New mobility or tourism services may emerge.

Especially in the capital region, open data could, for example, deliver added value for the methods and quality of human movement via the development of new mobility provision which is better coordinated and more easily accessible. The availability of data is also an essential prerequisite for the further development of artificial intelligence in order to enable us to learn from one another in an even more thorough way and thus achieve better outcomes. Data is an important asset for young and agile companies in the region with regard to developing and launching new services.

The States of Berlin and Brandenburg are already making data freely available on their open data portals.

Objectives of Cluster management

- Strengthen awareness of the benefits of Open IT in overall terms
- Strengthen awareness of open data and Open Access for trade and industry, government administration and citizens in particular
- Support the establishment of open data pools to foster economic, scientific and charitable applications, e.g. for the use of artificial intelligence
- Support the further expansion of open data and Open Access, including as a prerequisite for big data and AI applications

3.2 Focus: Processing

Artificial intelligence (AI)

Main innovation topics

Machine-based learning	Machine vision	Subsymbolic pattern recognition	Neural networks
Fuzzy logic systems	Processing natural speech	Search and optimisation	Knowledge representation
Probabilistic thinking	Planning and decision-making	Data quality	Data visualisation
Quality of algorithms	AI security	Ethical aspects of AI	KI as a service
Accessibility for SMEs	Data pools	AI training	

The main emphasis of the focus area of “Processing” is on technologies and applications which enable added value to be derived from data.

Processing large quantities of data is an important basis for the training of **artificial intelligence**. In order to be in a position to deal with and process a multitude of data from different origins and of different structures for the training of artificial intelligence and for other purposes besides, there is a need for the kinds of opportunities which are created within the scope of big data. The platform economy also derives added value from data.

The object of research into and the development and application of artificial intelligence is the **machine-based representation of human capacities** with the aim of **supporting** people with individual assignments (narrow AI) or even with a majority of their tasks (general AI).[6] The systems which are in place today constitute narrow AI. In order to develop general AI, a type of machine intelligence is required which facilitates the autonomous definition of objectives and the taking of the decisions needed to meet these objectives.

Endeavours to create machine-generated intelligence are particularly taking place against the background of the expectation of added economic and scientific value. This may lead to a situation where decisions and findings can be arrived at more quickly, more neutrally and more precisely and in a more founded way with regard to the data underlying these decisions.

In order to achieve this, information technology is being deployed in a functional manner, and findings and methods from the fields of **cognitive science, engineering, linguistics** and the **neuro and life sciences** are also being integrated.

As the performance power and applicability of algorithmically mapped artificial intelligence continue to develop, attention begins to turn to creative, design-related and categorisation issues of a societal, economic, ethical, political or legal nature.

6 Cf. [EC 19].

The breadth of this field of research may be illustrated by looking at the main subareas of artificial intelligence. The following are just some examples of where work on artificial intelligence takes place:

- Machine-based learning
- Machine vision and subsymbolic pattern recognition
- Neural networks
- Fuzzy logic systems
- Processing natural speech
- Search and optimisation
- Knowledge representation
- Probabilistic thinking (= thinking in probabilities)
- Planning and decision-making
- Data visualisation
- Data quality

Availability of a **large amount of relevant case-related and trustworthy data** is a crucial factor for the quality and reliability of decisions and findings arrived at or derived on the basis of artificial intelligence. In the interests of increasing trustworthiness, it is also necessary for the methods applied in the field of artificial intelligence to be **understandable** and **explicable (transparent)** in order to avoid so-called black box decisions wherever possible.

Relevance and potential for the region

The economy, the field of scientific research and policymakers have considerable expectations of the impact generated by systems and products which make use of artificial intelligence. The aspirations are to achieve new and better findings in the various specialist disciplines, to map **new services and functions** or facilitate these in the first place and ultimately to tap into **new sources of added value**. These requirements in themselves make it clear just how relevant the topic of “artificial intelligence” is.

The fields of application which offer potential or which have already been developed are cross-cutting and highly diverse. The initial successes and results to emerge from use cases reveal that the areas of outstanding significance will be artificial intelligence in the healthcare industry (e.g. for the identification of tumours or the development of new active substances), mobility (e.g. object recognition and action decisions in automated driving) and the energy sector (e.g. control of electricity networks). In the general commercial environment, artificial intelligence may also be able to support optimisation and decision-making tasks within the context of business intelligence and process management.

The deployment of AI systems could permit industrial production companies to improve the automation and quality of manufacturing processes or the maintenance of machines and plants as part of a predictive maintenance approach (Industry 4.0). Users of online platforms may receive more precisely tailored provision. Streaming systems can align their services and recommendations to individual customer characteristics. Financial companies can use artificial intelligence as a basis for making or giving investment decisions or recommendations. In specific situations, customer consultations can take place without a human counterpart via the use of so-called robot advisers, which adapt to the needs of the client.

What all these applications have in common is the requirement for sufficiently available, reliable and high-quality data which can serve as a basis for calculating decisions. In this sense in certain use cases, it will be necessary to use big data technologies to deal with data. The issue of handling data also encompasses questions relating to **IT security and data privacy** in order to counter manipulations or unlawful data outflows and uses. **Ethical** issues (e.g. Which decisions should AI be permitted to make?) and social questions (e.g. Will AI replace jobs?) are, however, also being explored.

The objectives of the European project to establish a sovereign cloud infrastructure **(GAIA-X)** are to create

requirements regarding performance, security and data privacy which meet the needs of such a European platform whilst also taking artificial intelligence into account and to provide a basis for European innovation in this area.[7]

Although the potential for the Berlin-Brandenburg capital region is considerable, the broad spectrum of possible application makes it difficult to put a figure on this. Looking at the ICT industry as a whole, the Berlin Technology Foundation calculated that there were around 223 AI companies in Berlin and Brandenburg in 2017. These companies employed approximately 4,900 staff and generated sales of just under €490 million.[8] This figure includes 64 start-ups.

Projections made by various institutions provide an insight into the amount of economic potential. These assume that AI companies will achieve a rise in turnover to just under €9 billion by 2025. This figure does not include AI-induced sales increases in the application sectors.[9]

Nevertheless, in order to tap into these areas of potential, further endeavours will be required in research and application-related development in the subareas of artificial intelligence stated above. The piloting and ultimately the introduction of AI systems in promising application sectors will also be needed. Whereas the IT industry is acting as a driver of innovation for the application sectors, the creative industries are embracing the available technologies for their own applications or acting as service providers for technology adaption.

An overview of existing IT expertise in the region would be useful in order to support research and development in the area of artificial intelligence and to move beyond evident use cases and tap into the broader economic spectrum.

Targeted support for young skilled employees in the area of artificial intelligence is of considerable significance for scientific research and for trade and industry. The availability of an excellent qualified workforce is a relevant location asset for companies. There is also a need for well-founded clarification of the status of technology and for a realistic portrayal of application examples.

The aim should be to strengthen the understanding of trade and industry of the applications and areas of potential of AI systems in order to achieve greater business deployment of AI by more companies.

One conceivable prospect could be a visible location for AI solutions which supports networking and generates an impetus for knowledge and technology transfer. Further specific networking formats at the regional, national and international level on various aspects of artificial intelligence may enhance the interchange of ideas and the visibility of the region.

Objectives of Cluster management

- Increase the quality of artificial intelligence data and algorithms and protection of user rights (→ secure, trustworthy AI)
- Support transfer of AI research to applications
- Increase accessibility for SMEs in particular, including via AI as a service and the establishment of data pools
- Support the establishment and expansion of training provision
- Increase the visibility of AI expertise in the region
- Strengthen awareness of application options and opportunities, especially for the local economy

7 See also [EC 18] and [EC 20c].

8 [TSB 18, pp. 22–23].

9 [TSB 18, p. 31].

Platform economy

Main innovation topics

IT infrastructure	Data management	Online platform	E-commerce
Big data	Artificial intelligence	Analysis of customer requirements	Platforms for regional providers

Digitalisation has given rise to a form of economy which puts its faith in new **value creation mechanisms** for trade, services, games, media formats, and communication. This is the platform economy. In a way which is comparable with the scale effects of industrial production, it builds on **exponential network effects** which arise as a result of the precise matching of supply and demand as the number of users increases.

Online platforms have now become a fundamental component of the digital world of consumption and services – for end customers and for interaction between companies. The growth of online platforms is being accompanied by a shift in market structures with regard to the generation of added values and in respect of the achievement of competitive advantages.

Whereas traditional providers which are aligned in a linear way will, for example, manufacture products and then be forced to maintain logistics and other infrastructures for this purpose, platforms make use of IT infrastructure, an online platform and data management. Data management, and therefore also technologies such as big data and artificial intelligence, have gained particularly in significance over the past few years in order to adapt services more effectively.

The platforms, whether these be online marketplaces, entertainment platforms or providers of financial or logistical services, are placing conventional providers under pressure. The pressure they face is to engage on the platforms as providers, develop their own models or to seek out new pathways in order to remain visible and maintain a presence on the market.

Relevance and potential for the region

The relevance of the platform economy is continuing to rise. Platform providers are looking for new services to offer via their platforms and are thus creating new platforms with specific services. There are virtually no economic sectors without any services delivered via platforms. Platform providers have also emerged in different sectors in the region. These may, for example, provide financial services.

Time and development cannot be turned back. It is clear that the market will continue to shift. The art will be to enable other players to tap into the potential offered by the platform economy for everyone's joint benefit. There are, for instances, initiatives within the region which aim to make it possible for small regional providers to use platform access for themselves and the region and to work together in order to establish regional platform services.

Given the fact that data is one of the mainstays of the platform economy, technical infrastructure is a further area of potential that players may be able to tap into. Others include the provision of big data technologies or artificial intelligence.

Objectives of Cluster management

- Present of opportunities and requirements
- Support projects aimed at regional participation in the platform economy
- Network those interested in using applications and providers

Big data

Main innovation topics

Descriptive analysis	Predictive analysis	Prescriptive analysis	Data collection
Data retention/storage	Data access	Data query	Data visualisation
Database systems	Communication networks	Privacy	IT security

Data is omnipresent. Every step, every click and every transaction in the digital world generates a **constantly growing quantity of multifarious types of data**. The Internet of Things, the use of web platforms, the production process or the use of vehicles all give rise to data which may represent an added value if, for example, it can be further processed by deploying artificial intelligence methods.

In order to be able to generate **added value from data**, suitable technologies, applications and methods are required which make it possible to handle the quantity of data as it grows exponentially. The term “big data” is used to refer collectively to relevant digital technologies. Such a designation is also symbolic of the sheer quantity of the data itself.

When analysis takes place of the structured and unstructured data which is available, interest centres on identifying correlations and on using these as a basis for deriving findings. Usually, these analyses and therefore interest in the type of findings that should emerge can be divided into three categories:

- A **descriptive analysis** aims to find out what has occurred in the past in order to arrive at an insight into the causes of successes or failures.
- A **predictive analysis** is directed towards the derivation of future developments.
- A **prescriptive analysis** investigates the impact of alternative action options in order to be able to make well-founded decisions.

Dealing with big data requires **many specific competences and technologies** in areas including data collection, data retention, data management, data access, data analysis and data query and ultimately also in the field of application-specific visualisation. Along this cascade of requirements there is, for example, a need for suitable sensors for data collection, for storage systems and databases (including in the cloud) and for hardware and software systems for the purposes of data management and analysis.

The collection and transport of large quantities of data and the use of such data in applications which are sometimes sensitive are also creating a growing requirement for effective **communication networks** which, depending on the application, are also real-time capable. This is also an area in which 5G mobile communications can make a contribution.

Last but not least, consideration must further be accorded to data privacy if large amounts of data are being collected, evaluated and used.

Relevance and potential for the region

Many sectors of the economy are already data-driven to a greater or lesser degree. The issue of whether or not this involves big data in accordance with the delineation presented above is less crucial than the fact that there is a fundamental need to work effectively and efficiently to generate added value from amounts of data which are both large and continuing to grow.

The assumption must be that there will be a further increase in the quantity of data, in the number of potential data sources, in the variance of types of data, and in the speed at which data emerges and arrives. Another assumption is that more data-driven use cases will develop. Numerous sectors of trade and industry are already reporting a need to improve their applications or to make such applications possible in the first place.

Big data in the healthcare industry, for instance, can use analytical methods of artificial intelligence as a vehicle for facilitating improvements in medical diagnostics. Companies can adjust their services to the needs of their customers in a more effective way. And automated or even autonomous vehicles can make decisions regarding navigation, direction and braking, and even more fundamental decisions on how to react, on the basis of large and varied data quantities. Various further possible areas of deployment could be described right across the economic sectors. However, it is already apparent that big data is a cross-cutting technology which is exercising an important supplier function. For the players in the region, this gives rise to the potential of using relevant services and applications to facilitate big data analyses for the different fields of deployment.

Objectives of Cluster management

- Strengthen interdisciplinary networking between key experts and application sectors
- Support knowledge, competence and technology transfer, especially to SMEs
- Support an innovation-friendly framework for the use of big data

3.3 Focus: Networking

5G applications and infrastructure

Main innovation topics

Enhanced mobile broadband connection	Ultra-reliable low latency communications	Massive machine type communications	Edge computing
Campus networks	Application-specific network architecture		

The “Networking” focus area addresses the technologies which are deployed to network data and devices. The 5G mobile communications standard lays the technical foundation for **networking**. The Internet of Things networks devices, whereas **blockchain** technology networks data.

The aim of the provision of the new 5G mobile communications standard (fifth generation) is to meet the **increased and increasingly heterogeneous requirements** of existing and conceivable applications. These can no longer be covered to a sufficient degree by available mobile communications technologies.

Mobile data use and the number of **networked systems communicating with one another** (see Internet of Things) are both on the rise. Applications such as automated vehicles or Industry 4.0 systems place high demands on the availability and latency of connections.

In order to take these enhanced requirements into account, 5G technology should be able to offer **improvements** including the following:

- Higher data rates
- Higher connection density
- Higher frequency capacity
- Higher data throughput
- Lower latency time
- Higher availability
- Better energy efficiency

However, one specific characteristic of 5G is that these properties cannot all be served in equal measure. Within the scope of development, therefore, fundamental **application scenarios** have been drawn up, for which the aim is to provide certain requirements spectra.

- **Enhanced mobile broadband** – availability of higher data rates for mobile broadband provision, including for cloud gaming, high resolution media, AR/VR applications and the networking of vehicles
- **Ultra-reliable low latency communications** – availability of reliable communications offering low latency times, e.g. for Industry 4.0 applications, autonomous vehicles, medical and security-critical applications
- **Massive machine type communications** – availability of a high communication density and a high degree of energy efficiency for IoT applications, for instance within the context of smart home, city and country, and for applications in the areas of energy generation, energy supply and logistics

Because performance requirements vary regionally and sometimes locally, a heterogeneous **application-specific network architecture** will need to be established under a so-called umbrella network. The requirements which pedestrian zones place on the network are different to those

created by industrial areas or by traffic routes with a high volume of networked vehicles operating autonomously.

A network which is designed on a smaller scale is required for the **expansion** or **development** of such a distributed infrastructure. The use of **edge computing** is necessary, for example, in order to realise applications with real-time requirements. The result of this is that data centres need to be erected across a wide area, in some cases every 50 kilometres, rather than being established centrally.

A further specific characteristic of 5G technology is that it allows companies to set up private so-called **campus networks** if necessary. Such networks enable individual application requirements to be realised, e.g. for the networking of machines and plants.

Relevance and potential for the region
Within the region, both in the Berlin metropolitan region and in the rural areas of Brandenburg, there is a clearly recognisable need for broadband provision which is able to meet fundamental and specific requirements. The availability of 5G mobile communications will not be crucial for all applications.

5G will be of particular relevance in areas where it can cover the specific performance requirements which arise from the various application scenarios, including those instigated by players in the Cluster. Space dictates that these can only be listed in summary form rather than in full:

- Internet of Things (e.g. smart home, city or country)
- Automated manufacture (e.g. Industry 4.0)
- Audiovisual media (games, film, TV, radio, music)
- Mobility (e.g. networked, automated and even autonomous vehicles)
- Healthcare industry (e.g. networking of medical devices)
- Energy sector (e.g. networking of plants for regenerative energy production)
- Agriculture (e.g. networking or automation of machines)
- Tourism (e.g. media-supported experience at popular visitor spots)

Companies in the region have the opportunity to participate in the development of 5G via application-specific solutions. The multitude of potential application scenarios offers ICT companies the chance to deploy their specific services in areas such as communication and data processing. Availability of 5G mobile communications allows the creative industries and media companies to develop and disseminate formats and contents of new qualities for mobile use. Optics and photonics companies based in the region are also making a contribution, e.g. via provision of microelectronics or glass fibre cables.

Availability of 5G can also open up new opportunities for applications companies operating in the various industries in the region to deliver their products and services. Experimentation with technical possibilities may constitute an initial step in terms of exploring the opportunities on offer and the relevant necessary requirements. Exchange of knowledge between providers and potential users represents an important basis in this regard.

Networks and initiatives
The Innovation Cluster 5G Berlin, in which various players are involved, is working to establish and operate a “5G Berlin Test Field”. This serves as a platform for experimentation for research and is open to experimental applications of industrial companies.

A series of events entitled “5G Week Berlin” is being used to present current developments within the context of 5G via demonstrators.

In Brandenburg (Welzow), cross-cutting work is currently ongoing with the State of Saxony to set up the “5G Lab Germany Research Field Lusatia”. The objective is to conduct research into the topics of teleoperated, automated and cooperative flying, driving and construction.

Objectives of Cluster management

- Strengthen awareness of application options and opportunities
- Encourage regional players to make use of the opportunities afforded by the 5G Berlin Test Field and the Brandenburg 5G Research Field in Lusatia
- Strengthen and develop a 5G application development ecosystem
- Support the acquisition and transfer of technological and application know-how, e.g. via interactive networking workshops or in pilot regions and real-world laboratories

Internet of Things

Main innovation topics

Sensor and effector technology	Embedded systems	Identification and localisation	Addressability of devices
Securing communication and cooperation	Use interfaces	Middleware platforms	Algorithms and software
Industry 4.0	Condition monitoring	Predictive maintenance	Artificial intelligence
Smart home/smart city/ smart country	Networked logistics systems	Networked transport	

The Internet of Things (IoT) is an internationally established term which describes using a digital communication connection to achieve the linking and information technology integration of any electronic systems in any kind of deployment context within an superordinate universal network.[10]

The word “Things” encapsulates the universal nature of the systems which may potentially be networked.

One fundamental goal of the networking is to provide the respective device with added value by using external, additional information.

10 [TSB 17, p. 10].

This creates informational and functional added value for the superordinate universal network and for its linked entities. Such an approach provides a means via which new and high-quality services, including automated services, can be realised for individuals and for authorised third parties.

Leaving the generic level behind, there are various **fields of application** and systems which can be identified for an Internet of Things. Objects of everyday use, such as electronic consumer goods in a private or business environment[11], production and logistics systems[12], transport and means of travel and equipment used in buildings or road infrastructure[13], can all receive an additional application-specific added value by being integrated into an Internet of Things.

Two examples of applications can be used to illustrate the deployment and benefits of IoT systems. Smart watches and fitness bracelets are increasingly being used in a private environment to record exercise and health data. The data collected can be analysed with regard to increased sporting performances and be compared with that of other users. This process enables health data to provide information on any anomalies. In industrial production, for instance, status-oriented maintenance can be realised via machine and plant data which is collected by sensors and analysed by computer systems (condition monitoring). This process can also serve as a foundation for the development of predictive maintenance if deployed in conjunction with technologies such as machine learning for the creation of artificial intelligence.

The **core technologies and infrastructure components**[14] for the structuring of an Internet of things include the following:

- **Sensor and effector technology** for the purpose of collecting data and information or for measurement of the impact of such data and technology on the surrounding environment
- **Embedded systems for data processing** such as microprocessors and storage systems
- **Technologies for identification and localisation** such as radio-frequency identifiers (RFID), Near-Field Communication (NFC), GPS and many more besides
- **Systems for the realisation of addressability** of the IoT devices
- **Technologies to secure communication and cooperation**, e.g. via radio technologies such as LTE, 5G, Wi-Fi, Bluetooth, NFC and many more besides
- **Use interfaces**, e.g. for the recognition of language, images and gestures
- **Middleware platforms** to ensure the interoperability of systems and technologies, e.g. via interfaces and standards
- **Algorithms and software** for the evaluation of data collected and the derivation of information and actions, e.g. also including via artificial intelligence (Artificial IoT)

The increasing number of networked devices means that consumption of energy incurred for communication is gaining in significance. This is especially important for systems such as sensors deployed in the streetscape, which may be very difficult or even impossible to integrate into the electricity network. Despite the large range, low levels of energy consumption can be achieved via the deployment of devices which use Low-Power Wide-Area Network Protocols (LPWAN). Various projects focusing on issues related to aspects of LPWAN are being actively pursued in the region.

IT security and data privacy, which are realised via hardware and software measures and protect both applications and users, are important within the context of the Internet of Things.

Relevance and potential for the region

The use of Internet of Things technologies promises to deliver **added economic value** both on the provider and the user sides. Users (private, business, scientific research and

11 For example, entertainment systems, computers, smartphones, wearables, smart home systems and household appliances.

12 See Industry 4.0.

13 See smart city and smart country.

14 Cf. [TSB 17, pp. 14–15]. Core technologies and infrastructure components frequently have their basis in technologies and services provided by the optics and photonics industries.

public) are also able to derive **added functional value** via more intensive and extensive use of data.

The relevance of the Internet of Things can also be measured against the respective individual or institutional added value which its use offers. The following areas of application can be stated as already being at the implementation or operational stage:

- Production (Industry 4.0, predictive maintenance)
- Mobility and logistics (including networked driving, sharing, logistics control)
- Energy (e.g. smart metering, smart grids)
- Healthcare (including the networking of medical devices)
- Retail (e.g. optimisation of warehouse storage)
- Infrastructure (smart city, country)
- Home and lifestyle (networked/smart housing and living)

Numerous industries can be identified as potential users and beneficiaries of the Internet of Things, especially in the capital region. This particularly applies in respect of the mobility and logistics, production, energy and healthcare sectors.

The region has a diverse **wealth of knowledge and competence landscape** in place. Universities, technical colleges and non-university institutes are carrying out research into fundamental and application-related solutions with regard to the core technologies of the Internet of Things.

Companies based in the region complete the **economic IoT ecosystem**.[15] These companies are primarily looking at the development and provision of technologies, products, systems, applications, platforms and analytical tools. The company landscape is mainly characterised by small and medium-sized companies, including numerous start-ups. As well as information and communication technology companies, the region is also home to various companies which develop and manufacture optical and photonic components such as sensors. These can also be used within the context of IoT.

Whereas the "Internet of Things" topic forms part of the product range at some companies, such as in the case of production systems, and therefore is used to a greater extent within these companies, there is frequently still too little understanding of potential use cases and of the economic and functional benefits. These need to be highlighted. One possibility could be provided by a demonstration and testing area for IoT applications, e.g. within the context of Industry 4.0, smart home, smart city and smart country.

Networks and initiatives
Since 2018, players from the Internet of Things ecosystem have been receiving assistance from the activities of the **Digital-Hub-Initiative "De:Hub Berlin IoT"**. The Federal Ministry for Economic Affairs and Energy is using this initiative to support the creation of digital hubs to foster cooperation between companies, entrepreneurs and the scientific research sector in Germany. Within the context of Industry 4.0, the **"GeoFab" Network** is actively involved in numerous projects relating to aspects such as localisation applications for the optimisation of process control.

Objectives of Cluster management

- Support and network the IoT players and of technology and know-how transfer, including via further development of the De:Hub Berlin IoT
- Tap into areas of potential for the IoT to deliver added value in cross-cutting fields of application and in connection with technologies such as artificial intelligence and blockchain
- Strengthen the visibility and international awareness of the IoT ecosystem in the region and deepen understanding of its technical, economic and social relevance
- Strengthen awareness of application options and opportunities, especially for the local economy

15 [TSB 17, p. 20 ff.].

Blockchain

Main innovation topics

Distributed ledger	Cryptography	Traceability of transactions	Use in the finance industry
Smart contracts	Peer-to-peer energy trading	Prosumer compensation	Proof of origin of energy
Digital identity	Self-sovereign identity	Supply chain management	Blockchain applications in production
Blockchain for public administration	Blockchain for mobility and logistics	Blockchain infrastructure	Interoperability
Interfaces	Standardisation	Data formats	

A blockchain is a special use case of so-called **distributed ledger technology**. Blockchain technology is used to verify data transactions of virtually any kind. A blockchain may be viewed as a database which is operated in a decentrally distributed way. Its data is stored in encrypted form in "blocks", which are linked via cryptographic procedures (hash chain[16]) in a tamper-proof way and map a transaction history in a time-sequential manner. A data block represents a depiction of transactions currently being actioned and of all previous transactions. The linking of the data blocks ensures the traceability of transactions.

The addition of new data blocks to represent transactions is conducted in accordance with a stipulated consensus mechanism agreed between the integrated partners of a blockchain and, following validation of the transactions, results in an updating of the whole blockchain for all partners. The distributed redundant operation and mutual agreement between the partners involved in a blockchain ensures that data is available in a tamper-proof and consistent form.

One major area in which the deployment of blockchain technology promises to deliver added value lies in the guarantee of **secure and trustworthy traceability** of transactions via technical measures undertaken to ensure the **integrity and authenticity** of transaction data.

Relevance and potential for the region

Over recent years, blockchain technology has mainly attracted public attention via the processing of various cryptocurrencies (e.g. Bitcoin and Ether) and is sometimes equated with this use case. The field of potential areas of application is, however, far broader. A blockchain may, for example, potentially be able to bring its specific benefits to bear in circumstances where

- processes in which various players are involved need to be structured in a confidential and transparent way,
- legal or organisational proof requirements are in place,
- uncompromised traceability of actions is needed.

Application scenarios can thus be identified in numerous industries.

16 A hash value is a theoretically unique depiction of data which is distorted by cryptographic calculations. A hash value therefore precisely represents a data set which in turn cannot theoretically be back calculated from a hash value. Verification of the integrity of a data set takes place via the matching of hash values.

Development activities need to be ascertained across sectors. Nevertheless, the main focus is on application scenarios which can be mapped in an organisationally efficient manner and which can be expected to provide the greatest added value. Particular mention should be made of the following in this regard:

- Finance services industry (national and international payment systems, securities trading, export financing)
- Business transactions (smart contracts)
- Energy sector (peer-to-peer trading of energy, prosumer[17] compensation, proof of origin of energy provided)
- Digital identities and self-sovereign identity (proof of own identity, e.g. in the case of transactions initiated online, and identity management)
- Supply chain management (transparency of production/ supply chains, e.g. in pharmaceutical logistics)
- Manufacturing (production data in the Internet of Things/Industry 4.0)
- Public administration (administrative processes and services for citizens, e.g. public certificates and attestations)
- Mobility and logistics (e.g. car sharing)

This summary can only offer an extract of the possibilities which are available. Nevertheless, the cross-cutting relevance and the potential of applications are apparent. It is, however, important to subject the added value for the respective use case to specific investigation.

Various scientific institutions in the region have included blockchain in their teaching and research schedule. They are focusing on fundamental and application-related technological issues whilst also turning their attention to industry-specific procedural or regulatory aspects.

Numerous blockchain companies have been established in Berlin alone. Accelerators, groups, co-working spaces and investors are all present in the region. Many contact points offer information on and initial access to investors, accelerators and event and co-working spaces.

The numerous blockchain companies located in the region largely deal with the development of blockchain infrastructures, i.e. with the fundamental technologies and logics on which a blockchain application can be mapped. The prevailing degree of networking is quite extensive. One of the reasons for this is the endeavour to achieve interoperability of technologies in the sense of standardisations of interfaces, data formats or cryptographic models.

The industry network BerChain e. V. lists more than 100 companies in Berlin alone which are looking at blockchain technology in their capacity as developers or providers. It is difficult to gauge the amount of potential for the region. Considering the current scope of the industry in the region, it is fair to assume that the potential for added value and employment will be significant if blockchain technologies undergo an expansion. Account also needs to be taken of the associated external impact of the region as a high-tech location.

Potential for the regional application sectors cannot, however, be firmly calculated and is not included in this consideration. Nevertheless, with regard to the promised benefits of deploying blockchain in various sectors, we may assume that it will be possible to realise considerable added value.

In order to move from potential to actual added values, it will be important to identify and pilot potentially suitable **“use cases”**, preferably in collaboration with companies located in the region. Public administration in the region will be able to take on a pioneering role in this regard. A further factor which can make a significant contribution is the creation of **transparency in respect of technology**, the possible added value it can deliver in various application scenarios and the competences and providers available in the region. An exploration of which regulatory adjustments are required by blockchain technology is of fundamental importance. In terms of dissemination, another important aspect is to establish an understanding about and of the technology so that evaluation competence is present amongst players in potential application sectors.

17 Prosumers are both the generators and purchasers of energy which is usually produced in a decentralised way. They may, for example, also include individual persons who draw energy whilst also producing it themselves at the same time and feeding this surplus back into the grid, e.g. via solar panels.

Networks and initiatives
Networking in the blockchain community is being driven by bodies such as the regional network BerChain e. V., which is perceived as a major player in the areas of support for co-operation, information and external representation.

The Blockchain Bundesverband e. V. operates at a national level with a strong regional emphasis. Its main focus is on lobbying for the blockchain community both nationally and internationally with regard to funding, applications and the general regulatory framework.

The “House of Blockchain” initiative is an interdisciplinary research team from the Berlin University of Applied Sciences and the Beuth University of Applied Sciences, Berlin, which focuses on imparting knowledge about blockchain technology for small and medium-sized enterprises (SMEs) in particular.

The Wildau Technical University of Applied Sciences is a scientific research partner in the “Blockchain zum Anfassen” initiative, in which it has joined forces with a Berlin-based IT company. The main thrust of the initiative is the practice--related representation of opportunities for the transparent mapping of logistics supply chains afforded by blockchain technology. It pursues its work in a practical laboratory in Wildau and via a roadshow.

Based in Berlin, govdigital eG is a cooperative with a national structure. It is committed towards the integration of IT solutions, including blockchain technology, within the public sector. The State of Berlin provides active support for this project. One way in which it is doing so is by pushing for ITDZ, the local government IT service provider in Berlin, to join the cooperative.

Objectives of Cluster management

- Support an innovation-friendly framework (legal position, state IT infrastructure and more besides)
- Cross-sectoral networking of regional players (companies, scientific research institutions, networks and associations)
- Communicate and disseminate regional beacon projects in various industries and in public administration where relevant
- Strengthen awareness of application options and opportunities, especially for the local economy

3.4 Focus: Use

Extended reality (XR)

Main innovation topics

Virtual reality	Augmented reality	Augmented visuality	Video recording
Sound recording and calculation	Scene analysis	Machine vision	Input devices
Output devices	Cloud services	5G	XR for games
XR for the healthcare industry	XR for manufacturing	XR for commerce	XR for initial and continuing training
XR for media			

The “Use” focus area is reaching a phase in which the main emphasis is on the deployment of technologies, methods and applications.

Extended reality is being put to increasing use in product design and in training in various industries and is also offering new entertainment opportunities. Unlike extended reality, geo IT does not generate any new worlds. In this case, the emphasis is on mapping the present world in a detailed way for purposes such as applications in agriculture or networked smart mobility.

Extended reality (XR) is used as a collective term which encompasses the immersive technologies of **virtual reality (VR)**, **augmented reality (AR)** and **augmented virtuality (AV)**, which supplement and combine the virtual and physical world.

In the case of virtual reality (VR), users wear a headset so that they can be completely integrated into a computer-simulated reality. In augmented reality (AR), the user’s view of the real environment is supplemented via computer-generated objects created by means of an interface (e.g. a headset or smartphone). In augmented virtuality (AV), a digital mapping of a real object, such as a person, is transferred into a computer-generated environment.

Even though AR and VR systems and applications have been available for many years in the entertainment industry, particularly in computer games, and despite the fact that industrial companies deploy them in areas such as product development, multifarious research and development challenges still remain. These need to be overcome in order to meet the requirements of a broader application spectrum.

This applies to the following aspects in particular:

- **Video recording** (including 360-degree videos, identifying 3D objects/scenes and volumetric videos)
- **Sound recording and calculation** (including 3D microphones, sound perception)
- **Scene analysis and machine vision** (e.g. 3D movement analysis, realistic modelling and animation)
- **Input and output devices** (e.g. 3D representation, VR/AR end devices, devices which perform a sensory and tactile function)
- **Cloud services and 5G** (e.g. for environmental mapping, more extensive applications)

Relevance and potencial for the region

XR technologies have the potential to bring about a significant change in the way in which interaction takes place with computer systems and objects in the environment. A further enriched level containing additional information, details and impressions is added to the three dimensions of our vision. Depending on the application, it is possible to obtain more comprehensive insights, gain new experiences and acquire additional findings.

New, even more sophisticated forms and versions of **computer games** which are ready for integration are merely one starting point for fresh or additional applications of the XR technologies. Applications designed by creative artists are already being deployed in the **creative industries (advertising) and in commerce**. These permit customers to virtually furnish their homes or try on clothes. In the **manufacturing industry**, opportunities for use are also available in development, in product design, in factory planning and in the production process in areas such as machine operation, quality control and maintenance.

Virtual elements can also be incorporated into **initial and continuing training**. Virtual training systems can be used to enrich time-consuming programmes such as learning how to weld or use fire extinguishers. Artificial intelligence methods can also be used to measure learning success, and learning contents can be displayed in a personalised manner. Systems which are able to achieve this are currently under development in the region.

In the healthcare industry, virtual mapping of the human body provides one way of supplementing the training of medical students. 3D images of patients can be inspected virtually for the purpose of diagnosis. During surgery, virtual systems allow their operators to display relevant additional information.

And last but not least, XR technologies also offer extra potential for media companies in terms of presenting their contents in a new way and creating fresh application-specific material.

The **higher education and non-university research institutes** in the region are carrying out fundamental and application-oriented research into the further development of XR technologies. Several institutes are also investigating how improvements can be made to technologies needed for the provision of XR systems and applications, e.g. camera and display technologies, transmission technology and data retention.

The business landscape relating to XR extends across the three areas of the Cluster – ICT, media and the creative industries. Media companies are, for example, producing 3D images and recordings, whilst creative artists are developing whole scenarios and worlds and generating stories and teaching contents. Regional ICT companies are making their own contribution by providing platforms and tools, methods to calculate the scenarios recorded and the necessary data transmission and data availability.

XR technologies offer the region the potential to create an economic ecosystem to which numerous creative minds, media operators and IT companies are able to add their expertise whilst pursuing their own further development.

Networks and initiatives

The XR community in the region is primarily assisted and supported by two networks. VRBB Virtual e. V. Reality Berlin Brandenburg acts as a thematically specific body, whilst Media:net berlinbrandenburg runs initiatives such as games:net berlinbrandenburg. The de:hub MediaTech Potsdam Initiative provides a basis via which companies, the scientific research community and networks can exchange ideas, pursue joint development and realise business ideas. There are also various so-called VR/AR meet-ups, such as the VRBLN Meet-up. Bitkom's Augmented and Virtual Reality Working Group operates at a supraregional level. 3IT Berlin, the Innovation Centre for Immersive Imaging Technologies, is a further institution based in Berlin.

Objectives of Cluster management

- Strengthen the visibility of regional competences in the development and application of technologies and for the development of XR contents, both for entertainment and industrial uses
- Foster knowledge transfer and interdisciplinary cooperation between regional players
- Support regional, national and international networking

Geo IT

Main innovation topics

Data collection	Data processing	Data visualisation	Modelling of geodata
Indoor/outdoor navigation	Satellite-aided earth recordings	Data linking	Navigation applications
Digital twin	Simulation	Industry 4.0	Position determination
3D point cloud	Mobility	Geo IT in agriculture	Geoinformatics

Geo IT operates on a small-scale (interiors) and on a large-scale (satellite-aided earth recordings) basis and deals with the collection, processing, visualisation and application of **spatially related information (georeferenced data)** for various use scenarios. The fundamental tasks are the recording, modelling and analysis of geographical data. This data can subsequently be linked with other data and analysed. Determining the optimum location for a company on the basis of regional market data is one example of the uses to which such information can be put.

Geoinformation shapes our everyday lives. If we want to go for something to eat, we consult digital maps to see which restaurants are nearby. A navigation application calculates how we can arrive at our chosen venue quickly and efficiently. These functions are based on precise and up-to-date geodata. They also use other linked data necessary for the specific application in order to achieve higher quality results.

A digital twin, for example, uses **highly precise recordings of spatial environments** to construct and simulate complex correlations in order, for instance, to explore the effects of construction measures. A combination of Industry 4.0 controls, highly precise position determination and

spatial 3D point clouds also enables simulations to be undertaken with extremely complex digital twins.

Relevance and potential for the region
Increased reliance has been placed in geodata over recent years, especially for the purpose of improving mobility, including by bicycle, by car or via public transport. The relevance of high-quality geoinformation will continue to grow in the coming years, particularly in the area of mobility. Highly automated vehicles have a primary need for very precise geographical data, which is supplemented by infrastructure data or data on weather conditions and updated in real time, in order to be able to make the right driving and navigational decisions.

In the agricultural industry, exact geoinformation on land areas can, for example, be linked with soil quality measurements in order to irrigate and fertilise more efficiently. In the case of generation of renewable energy via wind farms, a precise knowledge of the geographical circumstances at the locations can be combined with wind prognoses to improve simulation of electricity production.

Exact navigation is not merely of relevance in the streetscape or in rural areas. Automated logistics systems deployed in larger complexes of buildings will, for example, require precise knowledge of the relevant spatial circumstances.

Numerous players are active in the field of geoinformatics in the capital region. The growing relevance of highly precise geodata for various fields of application is creating economic potential for these players, and they need to seek to take advantage of this.

Networks and initiatives
The GEOkomm Association of Berlin/Brandenburg represents and supports companies and scientific research institutes in the region which are engaged in the area of geo IT.

The Association for Geoinformatics, Geo IT and Navigation has set itself the goal of supporting research and development, networking and training.

Objectives of Cluster management

- Support the expansion of availability of high-quality geodata
- Represent the regional competences of geo IT
- Encourage networking with key experts in the areas of big data and artificial intelligence and with potential application sectors

Information security and data privacy

Main innovation topics

Personal data	IT security/cybersecurity	Protection of analogue information	Protection of digital data and information
Critical infrastructure	Confidentiality of data	Integrity of data	Availability of data
Authenticity of data	Security by design and default	Privacy by design and default	Cryptography
Digital identity	Artificial intelligence	Blockchain	Secure software
Secure hardware	Secure communication	Awareness and training	

Information security takes risk and cost-effectiveness into account and encompasses the useful **technical and organisational securing** of data and information that is available in **analogue and digital form** (area of IT security/cyber security). Data privacy refers to the specific protection of personal data within the meaning of the law appertaining to informational self-determination and in relation to the legal provisions contained within the General Data Protection Regulation (GDPR).

The aim of information security is to guarantee the following:

- Confidentiality (protection of data against unauthorised access)
- Integrity (correctness of data)
- Availability (accessibility of data)
- Authenticity (credibility)

The aims of data protection are to ensure the **confidentiality of personal data** and to prevent the misuse of such data.

The relevance of having IT security which is appropriate to the current circumstances is growing as advancements take place in digitalisation and in the networking of end devices, business processes, software systems, products, offers, manufacturing environments, homes, and infrastructure. This affects data, information and communication structures alongside hardware and software. The objective is to **reduce and control the risk** that arises from a combination of threats and weak points.

Virtually every topic which is deemed to be a digital trend from a technical, functional and social point of view also needs to be considered from the perspective of information security and data privacy in order to realise the desired added value and reduce specific risks.

Particular mention could be made of the following in this regard:

- Digital communication and the communication networks used for this purpose
- Cloud computing infrastructure and applications
- Digital platforms and the data they use
- Artificial intelligence
- Big data
- Internet of Things
- Smart home, city and country

- Automated and networked vehicles
- Blockchain

In the best-case scenario, protection is put in place during the development process in accordance with the principle of "security and privacy by design and default".

Organisational/structural and personal measures, in particular **awareness and training** of employees and managers, are useful and sensible adjuncts to **technical measures** undertaken within the scope of IT security and data privacy.

Relevance and potential for the region
Information security is of relevance in all areas where data or information is collected, transmitted, processed and/or stored. This particularly affects organisations which are deemed to be critical infrastructures under the relevant Ordinance issued by the German Federal Office for Information Security (BSI). This includes energy supply, food production, healthcare as well as areas of media and culture.

There are, however, also theoretical implications for organisations whose operations depend on the confidentiality, availability and integrity of the data and information they use and which would suffer legal, economic or reputational damage in the event of a loss of one or more of these factors.

The IT Security Act 2.0 is predicted to view media companies as critical infrastructures in a stricter sense than was previously the case, and this approach will also include their suppliers. The consequence is that companies will need to undertake greater endeavours to put structural IT security in place.

Compliance with the requirements of data privacy is of economic significance to every company which works with personal data or with data that permits individuals to be identified. In order to meet the requirements, appropriate technical, organisational, structural and personnel measures are needed.

Contributions to IT security (within the scope of information security) may also emerge from developments in cryptography, in artificial intelligence, in the securing of digital identities and in blockchain. Detailed scientific expertise is available in the region in these areas, and the same may also generally be said for fundamental and application-oriented research and development. Additional efforts directed towards the training of skilled employees in the field of IT security would be conducive to the transfer of knowledge in trade and industry.

IT security is a topic being driven forward by the IT companies in the Cluster and which is creating product or service provision to benefit the application sectors. Ongoing technological development and digitalisation and an associated raising of appreciation within trade and industry mean that the services provided by the IT industry will become more significant with regard to IT security.

Ultimately, information security and data protection are primarily a question of awareness, i.e. consciousness of the economic importance and of the damage which may possibly arise as the result of an adverse incident.

Networks and initiatives
Within the region, the network "it's.BB – Netzwerk IT-Sicherheit Berlin/Brandenburg" is actively involved in the organisation of cooperation agreements with institutes of higher education, in the establishment of information security in the different industries, and in creating awareness of the significance of information security.

A nationally aligned transfer agency named "IT security in trade and industry" has been set up at the Fraunhofer Institute for Open Communication Systems in Berlin. In Brandenburg, an IT Centre of Excellence (KITS) based at the Leibniz Institute for Innovative Microelectronics in Frankfurt (Oder) will provide guidance. The focus at KITS is on industrial IT security. The SME 4.0 Centre of Excellence in Cottbus is assisting these efforts by providing support for exploration of the topic of "IT security in the office environment".

Companies in the region are also able to avail themselves of the services of a "Central Point of Contact for Cybercrime" (ZAC), which is operated by the police.

Objectives of Cluster management

- Strengthen awareness and understanding of information security and privacy, especially amongst SMEs and in the media industry
- Foster networking and the exchange of ideas to achieve greater expansion of evaluation competences
- Support knowledge, competence and technology transfer

3.5 Technology monitoring

Not every topic is already sufficiently advanced so as to allow a prediction of the added value it may produce for the economy, scientific research or society. In some cases, it is not yet possible to foresee how a topic will develop or whether it will occur at all and when. Although a lack of certainty is inherent in technology, the fields of innovation contained in the Master Plan address themes for which some degree of sureness exists with regard to each of these variables that an answer can be provided.

But the objective is also to monitor topics which are still tentative. It is clear that innovation cycles can be extremely short and that successes can sometimes be achieved more suddenly than was expected. Development in certain technologies will continue to be monitored in order to be prepared for this eventuality.

From today's point of view, developments in high-performance computing (HPC) and in quantum technologies seem to be particularly promising in terms of delivering fresh innovations, some of which are revolutionary in nature. One aspect of the quantum technologies, the quantum computer, offers a new form of calculation.

Over the term of the present Master Plan, it is certainly possible that further topics worthy of greater consideration will emerge. An analysis will then be conducted to arrive at a decision as to whether such themes will be included in the technology monitoring.

High-performance computing (HPC)
The term "high-performance computing" describes extremely capable systems with calculation and storage capacities which are able to cope with the constantly increasing requirements of the scientific research sector and trade and industry for the modelling, simulation and parallel processing of complex issues. Because technical developments are proceeding on an ongoing basis, no clearly defined delineation of high-performance computing is in place. However, the main factor for the evaluation is an ability to carry out calculations which cannot be accomplished by conventional workplace computers.

Scientific applications exist in fields such as energy and climate research and astrophysics. Trade and industry has and is beginning to experience a need for high-level calculations

within the context of applications which relate to artificial intelligence in grid computing, to the Internet of Things or to the complex computations occurring in the financial industry generally. The advent of new fields of application, of increasing networking and of the need to process large quantities of data more rapidly and more precisely is leading to increased cross-domain demand for high-performance computing, including on the part of regional SMEs. European computing capacities are currently only able to serve a small proportion of this demand, and scope for commercial purposes is limited. In Germany too, there is an increase in the degree of commitment being shown to the development of HPC systems and to the expansion of capacities.

Development of high-performance computing systems is primarily taking place in the areas of lower-power processors, HPC software engineering, middleware technologies, algorithms and system architectures, HPC applications and services, and especially in the field of pursuing further development of the next supercomputing generations.

In the region, a high-performance computing system is being operated at the Konrad Zuse Centre for Information Technology at the Free University of Berlin. Access to three systems operated in Germany is available via the Gauss Centre for Supercomputing. The University of Potsdam is also carrying out research into parallel systems.

Availability of and access to high-performance computers can limit the development of potential, including and particularly for economically related applications. Demand will continue to grow over the coming years, and this will be accompanied by an increasing need for available systems and for competences to permit the implementation of applications on the basis of such systems. These requirements will have to be taken into account in order for the region to tap into the available areas of potential.

Quantum computing

Quantum computers, or post-digital computers, have gained broader public attention, especially in the wake of the so-called declaration of "quantum supremacy"[18] made by the Google AI Quantum Team in July 2019 [AF 19]. Whereas some are already predicting that conventional computer systems will be replaced in the short term, others take the view that suitability for business-related purposes will not be achieved for a further 10 to 20 years. The instability of qubits, the basic unit of quantum information, is one of the numerous obstacles to be overcome.

The performance power of quantum computers is strongly dependent on the realisable number and quality (effectively usable number) of the qubits deployed. The current status is that achieving the required number and quality of qubits to permit business applications will not be feasible in the short term.

One expert assessment is that quantum computers will tend to operate **alongside conventional systems** in future, acting as a coprocessor to supplement the latter for specific tasks. This is because the benefits offered by quantum computers will not take sufficient effect for conventional calculations.

The current state of knowledge indicates predicted use cases in areas such as the secure transmission of information (quantum cryptography) and simulation. Theoretically, benefits could also emerge for software verification (simultaneity of test runs) or for the design of blockchain technology.

No realistic estimations of areas of economic potential for the region can as yet be arrived at. Scientific competences in the field of quantum technologies are present in the region, particularly in quantum sensor technology, quantum communication and quantum simulation. Scientific research players in this sector include the Ferdinand Braun Institute, the Humboldt University of Berlin, the Technical University of Berlin, the Free University of Berlin, and the University of Potsdam. Various institutes attached to the Fraunhofer, Max Planck, Helmholtz and Leibniz Associations and Societies are also turning their attention to different topics relating to quantum technology.

If the potential offered by quantum computing is to remain available to the region and be successfully accessed in future, there will be an initial requirement to **delineate and network available scientific research competences and to monitor technological developments**.

18 Quantum supremacy refers to the superiority in terms of necessary calculation time for a complex task offered by computers whose calculation function is based on the laws of quantum mechanics as measured against so-called supercomputers operating in accordance with the digital principle.

3.6 Overarching integrative and cross-sectoral topics

The activities undertaken by the players in the individual sectors and industries within the Cluster are not merely determined by topics that are related to technology, products or methods. Cross-cutting issues also create challenges for the players and are thus also of significance to the Cluster. The following topics will be highlighted here:

- Prioritising sustainable innovations
- Qualified workforce
- Areas and locations
- Smart city and smart country

Prioritising sustainable innovations
Within the scope of the Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025), the Cluster aligns itself to the action principle of sustainability and accords priority to sustainable innovations. Account is taken of ecological objectives, of the economic and social aspects of sustainability, and of the overarching climate protection aims of the states.

On the one hand, sustainability relates to the actions undertaken in the Cluster itself. It is, for example, possible to cut the amount of energy needed for information and communication technologies. The use of rare earth elements and other critical raw materials required for the production of ICT hardware can also be reduced. The creative industries are making a contribution to ecological sustainability by adopting a sustainable (eco) design approach. This may, for example, involve opting for natural or used materials (upcycling). They are also improving the functionality (usability) of everyday objects and thus also assisting with social sustainability.

Like in other areas too, the Cluster acts as an enabler in the field of sustainability by facilitating sustainable actions by third parties. Measures relating to digitalisation provide a particular vehicle for this. Sustainability is a task for both society and the economy as a whole, to which digitalisation can make a major contribution.

Expanding the closed-loop economy, i.e. the circular process encompassing product manufacture, product use and ultimate recycling or reuse for a different purpose, constitutes a building block within the framework of ecological sustainability.

The competences and outputs created by digitalisation have the potential to become a driver of this circular economy. Digital technologies can offer new opportunities at different points. This may take place via the following means:

- Monitoring the product life cycle by using digital twins
- Digital labelling of packaging to increase precision of sorting in the recycling process
- More exact predictive monitoring of manufacturing processes to reduce waste
- More precise and consistent information on supply chains
- Using the networking facilitated by IoT technologies to trace products and the way they are used throughout the life cycle

Digitalisation is also necessary for measures such as smart metering, smart grids or virtual power stations in a sustainable energy sector. Finally, digital communication technologies render long transportation distances superfluous and thus help avoid the associated environmental pollution. During the coronavirus pandemic, it can even be said that video conferences have helped maintain business processes and have therefore made an important contribution to economic sustainability in many industries alongside the positive ecological effect they also impart.

The Cluster is delivering a particular impact on sustainability within the scope of the activities it pursues in relation to smart city or smart country. Especially in rural areas, digitalisation is helping to improve social participation and is even in some cases bringing about a comprehensive revival in the countryside. Digitalisation is expanding the action options available to rural dwellers whilst also making these regions attractive in terms of the influx of digital workers (for further information, see below).

Qualified workforce
The availability of a qualified workforce is not merely a challenge for companies in the Cluster. As digitalisation progresses and extends across all industries, the acquisition

of skilled employees in possession of digital competences represents a crucial bottleneck for digitally oriented companies in the region with regard to the retention and improvement of competitiveness. The further one moves away from the centre of Berlin out into the edges of Brandenburg, the greater will be the challenge of finding suitable or sufficient IT workers. “Low code” and “citizen developer” are two approaches which offer an opportunity to build up digital competences and to apply these without a detailed knowledge of programming.

Endeavours on the part of numerous players are required in order to overcome this challenge. The following actions may help in this regard:

- Increasing visibility of the industries in the Cluster
- Increasing the availability of information on the occupational profiles within the industries (for those who have completed academic qualifications and vocational education and training)
- Supporting women who wish to enter STEM occupations
- Strengthening diversity in the world of work
- Facilitating and establishing “new work” (alternative worlds of work)
- Driving forward networking between companies, the scientific research sector and education and training establishments
- Advancing digitalisation in schools
- Strengthening the possibilities offered by low code applications and services and by “citizen developer” (programming without formal programming knowledge)
- Training existing staff via short courses which reflect the latest developments in key capacity areas (advanced digital skills)
- Increasing the attractiveness of the capital region for skilled employees

Areas and locations

The availability and affordability of areas/locations represent a growing challenge for companies in all industries covered by the Cluster. This is relevant in terms of attractiveness for a qualified workforce, including skilled employees from abroad, and also exerts an effect on the development and even sometimes on the existence of companies. These shortages are leading to displacement in the creative industries in particular, e.g. in the case of clubs or artists.

Smart city and smart country

Berlin’s Smart City Strategy[19] pursues the vision of developing an intelligently networked, sustainable, post-fossil and resilient location in order to retain and enhance attractiveness and quality of life. The aim is to use smart technology to identify solutions for the ecological, social, economic and cultural challenges that Berlin faces.

Six overlapping action areas – “Smart administration and urban society”, “Smart living”, “Smart economy”, “Smart mobility”, “Smart infrastructures” and “Public security” – are being used to drive forward numerous projects which can help make the vision a reality.

Smart Country[20] is a specific topic for the State of Brandenburg, which is being pursued by its Economic Development Agency in conjunction with partners from the field of research, with various associations and initiatives, and with further players from Berlin and Brandenburg. Smart Country Brandenburg can be delineated from a smart city approach in that the focus is on illustrating, discussing and implementing the new perspectives which digitalisation and a digital economy are creating for implementation in rural areas.

19 Available online at: https://www.berlinpartner.de/fileadmin/user_upload/01_chefredaktion/ 02_pdf/02_navi/21/Strategie_Smart_City_Berlin.pdf.

20 Available online at: www.smartcountrybrandenburg.de.

Smart Country Brandenburg

- is an approach aimed at initiating and supporting digital locations and projects,
- seeks to use digitalisation for technological development and new forms of work,
- offers an opportunity to lend new impetuses to life in the countryside,
- supports development of the capital region and of rural areas.

The objective is for digitally supported living and working to stimulate social and economic innovations, and a further aim is to enhance the attractiveness of rural areas as a place to live and work. Digital networking, co-working spaces, start-ups in rural areas and social entrepreneurship are some of the entry points for this development. The plan is to join forces with local initiatives and companies to design and pilot the approaches and make them usable. Regional real-world and innovation laboratories, in which new regulatory, organisational and technological approaches can be tried out, are one of the options which offer space and opportunity in this regard.

Key projects attaining implementation and visibility are the linchpin of the work. The structural shift being occasioned by digital work and digital transformation represents an opportunity for rural regions and may also reduce the pressure on commuters and help bring companies and skilled employees together. Networking between rural areas and between the city and the countryside has an impact on topics related to general public services, such as mobility, local supply, energy and sustainability, healthcare and nursing, working and living and administration. Smart Country Brandenburg uses the possibilities created by digitalisation as a vehicle to link entirely different clusters to form new ways of delivering impacts and services such as telemedicine in rural areas, new logistics and distribution concepts in the food industry or manufacturing using 3D printers outside industrial locations. The players involved in Smart Country Brandenburg attach particular significance to sustainability.

These smart city and smart country concepts are intrinsically connected, and each affects several local government departments in Brandenburg and Berlin respectively. "Smart Country Brandenburg" is the equivalent of "Smart City Berlin". Smart Country Brandenburg consists of smart villages, smart regions and smart cities in the State of Brandenburg. It encompasses all districts and urban districts in which several players have come together to initiate sustainable regional development at a local level. Numerous companies are engaged in providing the impetus for change. Hubs, labs and spaces are emerging across all areas of the state.

4 Guidelines and key focal points of the Joint Innovation Strategy

4 Guidelines and key focal points of the Joint Innovation Strategy

Key focal points	Guidelines
1. Digitalisation	1. Broaden approaches to innovation
2. Real-world laboratories and test fields	2. Strengthen cross-clusters
3. Work 4.0 and skilled employees	3. Open up innovation processes further
4. Start-ups and new businesses	4. Prioritise sustainable innovations
	5. Achieve a more international alignment

Table 1: Key focal points and guidelines of the Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025)

The States of Berlin and Brandenburg have further developed the strategic alignment of innovation policy in the region by updating their Joint Innovation Strategy (innoBB 2025). The emphasis is placed on four key focal points under an umbrella provided by five fundamental guidelines. These will sit alongside the separate innovation topics being pursued by the individual industries and set out the direction of travel for the work of the Cluster over the coming years.

The following sections provide a summary of how the Cluster is contributing to the key focal points and guidelines.

4.1 Digitalisation

Digitalisation is the topic which essentially shapes the Cluster ICT, Media and Creative Industries. The players in the Cluster act as initiators, designers, drivers and imparters in the emergence and establishment of new digital technologies and applications.

Digital innovations such as artificial intelligence, the Internet of Things, 5G mobile communications and the self-evident technologies which determine our lives today, such as the smartphone and the Internet, all have their **origins in the heads of players from the information and communication technology industry**. The creative industries are also making an important contribution to the development of innovative applications. Nevertheless, both technical and non-technical innovations are frequently not just the result of work carried out in a single industry or in one domain of knowledge. New things are much more likely to be created via interplay with the development of fresh findings in other sectors, such as electrical engineering, photonics, and via a knowledge of the market requirements and possibilities.

Nowadays, there is virtually no sector of trade and industry and almost no office or shop floor process that is able to do entirely without digital support. More and more scientific findings are being generated, and these are also being increasingly stored in databases and published digitally. **Digital technologies are an integral part of our lives.** We buy products online and stream films at home. If we visit the cinema, films are shown from a hard disc rather than from a reel. The vehicle which transports us is changing from an encased engine with tyres into a motorised computer.

Applications, processes and business models are being digitalised. The aim is to make them more efficient, more networked, faster, smarter and universally available. But digitalisation, which has such a dynamic and disruptive effect on broad sections of the economy, does not always take place in accordance with the same pattern. Neither does it proceed at the same speed or to the same degree. Situations and starting points vary. Nevertheless, digitalisation will also leave its mark on those who have had little to do with it thus far. People will be required to keep pace. In such a constellation, the players in the Cluster act as drivers, translators, imparters and implementers.

The Cluster's supporting and mediating role offers the digital drivers, the developers of basic technology and the users a digital platform on which they are able to engage in

networking, initiate cooperation agreements and draw on new impetus in order to derive added value from digitalisation.

This provides opportunities to shape new solutions and to establish contact with potential cooperation partners and users.

4.2 Real-world laboratories and test fields

Innovations need a place in which they can be subjected to detailed testing. A place in which **trials, experimentation and improvements** can be carried out under **suitable conditions**. The real-world laboratories and test fields model aims to facilitate the establishment of such places, at which experiences can be gathered under application-related conditions. The objectives are for them to offer governance spaces which make it possible to use the regulatory scope thus afforded to carry out piloting, to permit regulatory learning to take place, and for findings which emerge from the real-world laboratories and testing fields to exert a timely effect in terms of creating a framework that will allow the establishment of innovations on the market to proceed more rapidly and more smoothly.

Digital innovations are well known for frequently causing a **disruptive effect** on the market, and they are also associated with radical changes in a multitude of cases. These are changes which have brought challenges for many – for market participants, for legislators and also for the developers of innovative applications themselves. Especially in the digital sector, existing regulatory stipulations tend to inhibit the establishment of new services. Many of these are particularly dependent on being launched quickly so as to become the first on the market.

Both the **adaptation of the regulatory framework** and the **development of ecosystems** relating to new digital technology can be accelerated if experiences can be gleaned at an early stage. Using the areas of design latitude which real-world laboratories and test fields should be able to supply can help new applications to achieve success as well as creating a market and a market environment for such applications.

The Cluster clearly has a requirement for venues at which experimentation, mutual learning and collaboration on a new solution can take place. Developers and providers of technologies such as extended reality, artificial intelligence, blockchain, 5G mobile communications and players from the creative industries are seeking opportunities to shape new solutions and to enter into contact with potential cooperation partners and users.

4.3 Work 4.0 and skilled employees

Digitalisation is changing work technically, organisationally and culturally. The new digital worlds of work are producing both new opportunities and challenges. Work may, for example, become more mobile and provide new communication pathways. It is, however, also making new demands on the knowledge and competences of employees. Knowledge moves faster than ever and will only continue to speed up. The learning which skilled employees acquire during training is no longer sufficient for the entire duration of working life. Lifelong learning has ceased to be merely a chance to climb new rungs of the career ladder. It has become a necessity for many people as they seek to keep pace with development.

Companies in the ICT, media and creative industries also need to be ready to meet these challenges. They face the tasks of finding qualified employees who in some cases must be in possession of knowledge which is ever more specific and ever more digital in nature. They also have to provide the right training to their existing employees and retain these within the company.

Digital training is a significant key for individual persons, but it is also a vital foundation for companies which wish to continue to innovate in the digital cosmos. In a world of work which is being shaped by a constant shift brought about by digital technologies and applications, lifelong learning is becoming increasingly important in order to be able to participate over the course of a lifetime.

The educational landscape in the region offers a broad basis for offering training for skilled employees and further development which is digitally geared, e.g. including via individually aligned approaches which use artificial intelligence and augmented reality. Within this process, it is important for companies to be familiar with their own needs and the requirements of the market and to gain an overview of the education and training system.

4.4 Start-ups and new businesses

Many business models created by start-ups indicate a high proportion of digital services. They are based on the opportunities afforded to these companies by digital technologies in terms of delivering performance and appealing to customers. The capital region is a European stronghold of start-ups. Measured by the amount of venture capital investments made in 2019, it currently occupies the sixth position in the world in this regard. Many of the start-ups located here can be allocated to the Cluster.

For this reason, the Cluster has a particular interest in maintaining close ties with the start-up community and with the networks and associations which represent it, such as the Federal Association of German Start-ups. It is also important to foster networking between the start-ups, SMEs and industry in the region.

4.5 Internationalisation

Internationalisation is well advanced amongst many players in the Cluster and forms an important part of company strategy in some cases, especially in the information and communication technology and media industries. In ICT, both research and development and service provision are increasingly taking place at an international level.

Technical developments in ICT and in the media are being driven forward globally and are exerting an impact on the way in which players in the region work. International networking is a particular requirement for topics such as artificial intelligence, the Internet of Things, blockchain and 5G mobile communications.

Demand for the products and services of the Cluster players does not recognise any state borders. Neither are state borders of any relevance to the way in which these products and services are generated. The increase in online provision means that demand may emerge at any time and in any place.

Many companies and scientific research institutes within the Cluster employ an international staff. IT is one particular industry in which expertise is distributed globally, and this is frequently reflected by employee structures.

It is therefore essential for the companies in the Cluster to align their economic activities internationally. Support in this regard is provided by the Cluster itself, by its partners, the Enterprise European Network (EEN) and a Cluster Internationalisation body (CLINT), and by the regional chambers and networks.

Support provision from the economic development agencies and chambers in the region is available in areas such as the following:

- Information on the EU funding system
- Assistance with submitting applications for EU funding programmes
- Arranging cooperation partners for research, development and innovation projects
- Identifying business partners on delegation visits or at trade fair appearances
- Providing information on foreign markets
- Imparting intercultural competences
- Providing information on the financing of foreign trade

4.6 Cross-cluster

Networking has taken place with representatives from other clusters in the region to identify topics and tasks in respect of which the Cluster ICT, Media and Creative Industries will be able to use the excellence of its players to make an important contribution to these other clusters over the coming years.

Fields of application	ICT, Media and Creative Industries as drivers of cross-cluster innovations
Energy technology	• Production prognosis and timely distribution of renewable energy via artificial intelligence • Overview of wind power generation plants to act as a basis for generation prognoses (geo IT) • Smart home solutions (IoT) • Infrastructures of critical importance to IT security • Decentralised energy generation and sale • Augmented reality in initial/continuing training and in maintenance • Explanation of the energy transition via digital storytelling
Food industry	• Traceability of food supply chains (blockchain) • 5G mobile communications for agricultural machinery • Geo IT for assessments of soil quality and soil conditions • Augmented reality in machine maintenance • Digital platforms for food distribution
Healthcare industry	• Medical image analysis (e.g. tumour recognition) and development of new active substances via KI calculations • Provision and evaluation of anonymised healthcare data for the research of diagnostics and treatment methods • Infrastructures of critical importance to IT security • Blockchain technology in the use of electronic patient records • Traceability of the supply chain in pharmaceutical logistics via blockchain • Networking of medical devices (Medical IoT) • Augmented reality as a supplementary source of information in the operating theatre • Digital storytelling to provide medical explanations to children or via the use of simple language • Serious games for the purposes of dementia prevention/treatment and for the rehabilitation of stroke patients (the creative industries as an impetus provider) • Human-centred design (usability) for designing medical devices in a way which prevents operator errors • App-based medical services (digital business models) • Wearable devices for healthcare sensory technology and easy visualisation of health data

Plastics and chemistry	• Artificial intelligence for the analysis of process data • Supply chain and production chain traceability via blockchain • Augmented reality for initial and continuing training and for chemical and plant maintenance • 5G campus networks for process industry • Geo IT for the monitoring and control of production and supply plants • IoT sensor networks for quality and production measurement in process industry • Digital storytelling for industry marketing and for the acquisition of skilled employees/young talent • IT security for manufacturing companies, in particular for industrial control systems • Wearable devices in manufacturing environments • Digital order processes (digital business models)
Metal working	• 5G campus networks for manufacturing companies • Traceability of the supply chain via blockchain • Internet of Things (Industry 4.0) in manufacturing • IT security for manufacturing companies • Using big data and artificial intelligence to generate added value from production data • Augmented reality for marketing and training in construction, digital twin and maintenance • Digital storytelling for industry marketing and for the acquisition of skilled employees/young talent • Gamification and design thinking in initial/continuing training and innovation processes • Wearable devices in manufacturing environments
Tourism	• Digital platforms for marketing, agency activities and combined service provision • Big data and artificial intelligence for the development of customer-specific offers • Augmented and virtual reality for additional digital guest experiences • Geo IT for location-based services • IoT solutions for smart buildings management • Processing of reservations and offers via blockchain solutions
Photonics	• Artificial intelligence in biomedical optics and interplay with optical sensor technology • Production traceability via blockchain • Big data in analysis and medical diagnostics and in combination with data from optical or microelectronic/nanoelectronic sensor technology • Communicative integration of sensors and laser-optic systems in the Internet of Things • IT security in companies and technologies in quantum cryptography • Headsets/displays, sensor technology and camera technology for augmented and virtual reality

Transport, mobility and logistics	• 5G for the information-technology networking of vehicles • Augmented reality for maintenance and routine repair in vehicle manufacturing • Artificial intelligence for object recognition, decision making and route management in automated driving and for predictive maintenance in production • IT security in the companies • Blockchain for logistics and traceability of manufacturing/supply chains, e.g. pharmaceutical logistics • Geo IT for transport, mobility and vehicle pool management, autonomous systems and digital maps • Open data and open interfaces for mobility services, automated functions of vehicles and route management in logistics • User experience for human-machine interfaces in vehicles • Digital platforms for transport management and logistics, public transport mobility platforms • Internet of Things in vehicle manufacturing (Industry 4.0)

Table 2: Selection of cross-cluster bridges between the Cluster ICT, Media and Creative Industries and other clusters active in the region

4.7 Aligning innovations in a broader, more sustainable and more open way

When mention is made of a **broader alignment** of innovations, the intention is to point out that the focus of innovation should be geared towards both technical and non-technical innovations. In the description of the self-conception of the Cluster, an explanation was provided as to how this should be interpreted and as to the significance accorded to non-technical innovations by the Cluster players.

Non-technical innovations are an important component of the innovation activities undertaken in the Cluster. New products and services created by the players in the Cluster are frequently characterised by the fact that they primarily focus on the **purpose of deployment** and on the surrounding **ecosystem** rather than merely on the technology. New interaction models or new methodological approaches towards solving problems are, for example, also taken into account in determining added societal value. Nevertheless, supporting developments which are of a non-technical nature at their core also remains an **important task** alongside technological development.

Sustainable innovations bring together **ecological, economic** and **social** perspectives. An ecological innovation will not meet with a very positive economic and social response if it cannot be portrayed in economic terms and if it is not socially compatible.

Active work aimed at achieving a more sustainable alignment in the respective industrial sectors is ongoing in all three Cluster areas. ICT is both a tool for and an object of this development. Computer services consume energy, but they can also be used to identify areas of potential energy savings. The reparability of ICT products is one further aspect amongst many. Capacity for recycling or upcycling is another issue being considered by the ICT industry. The media industry is pursuing approaches which aim to design film productions or music festivals in a more sustainable way. The creative industries are looking at issues such as sustainable/eco design.

Open innovation processes have in many cases been fully embraced in practice, especially within the context of ICT, the media and the creative industries. New ideas, methods, products, software, films or articles or clothing are developed in collaboration with various players of different types. Within the scope of Open IT, the ICT industry has established a movement which is strongly based on a process of open innovation.

In its capacity as a cross-cutting cluster, the Cluster ICT, Media and Creative Industries maintains close links with other clusters in the region with the aim of supporting networking between players in various industries.

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5 Bibliography

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