# NPA DISRUPTIVE TECHNOLOGIES CAPACITY EVALUATION REPORT

# Document history

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# 1 Executive summary

The purpose of this document is to assess the existing disruptive technologies capacities available in the NPA.

It is the result of the process followed by the DISTINCT partners which have included desk research, consultations and interviews with target groups that in this case are the research centres, universities, colleges and companies, owners of the know-how on disruptive technologies solutions.

The identification process has focused in the potential application of disruptive technologies, in particular Internet of Things (IoT), Artificial Intelligence (AI), Virtual Reality/Augmented Reality (VR/AR) and Blockchain, into the public service areas addressed in the project, namely, health and care, environmental management and training.

*Note: this report gathers an initial number of organisations and examples of application of disruptive technologies across the NPA area. It is aimed to be the starting point to identify the existing expertise that can be unlocked for improved quality and sustainable services. If you are aware of additional expertise that could be included we invite you to share it by contacting us at info@ernact.eu*

# 2 Disruptive technologies in DISTINCT

Disruptive technology is an innovation that significantly alters the way that consumers, industries, or businesses operate. A disruptive technology sweeps away the systems or habits it replaces because it has attributes that are recognizably superior.

In DISTINCT we focus on the following disruptive technologies:

• **Internet of Things (IoT):** describes the network of small physical objects, that are packed with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet.

• **Artificial Intelligence (AI):** describes software, machines, computers or devices that can mimic functions of the human mind such as learning, perceiving their environment, solving a problem or successfully achieving goals.

• **Virtual Reality (VR):** use of special headsets/devices to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual environment. The user is able to look and move around and interact with virtual objects.

• **Augmented Reality (AR):** interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities.

• **Blockchain**: Blockchain is a growing distributed list of data records, called blocks, linked using cryptography. It is resistant to modification and can record transactions between two parties efficiently and in a verifiable and permanent way.

# 3 The NPA context

## 3.1 IoT in public sector – NPA Outlook

This section reports the use of IoT within public sector organizations in the NPA region. IoT is here used as a collective term to define physical objects, e.g., sensors, beacons, actuators, mobile phones, etc., that are constructed with sensing and processing capabilities as well as network connectivity. Further, IoT allows devices to store, process and communicate data with one another without necessarily involving human intermediaries.

IoT has become a more mature technology since trends such as mobile IT and changes from closed to open systems resulted in cheaper, more capable hardware and low-power wide-area networks, for instance SixFox, LoRa, LTE-M and 5G. Additional data showing that IoT is no longer an emerging technology in society is that the expected IoT-spending will surpass 1 trillion USD by 2022 (Taylor, 2019)[1]. The market size is of course smaller in the Nordic countries, but has grown for at least the last five years.

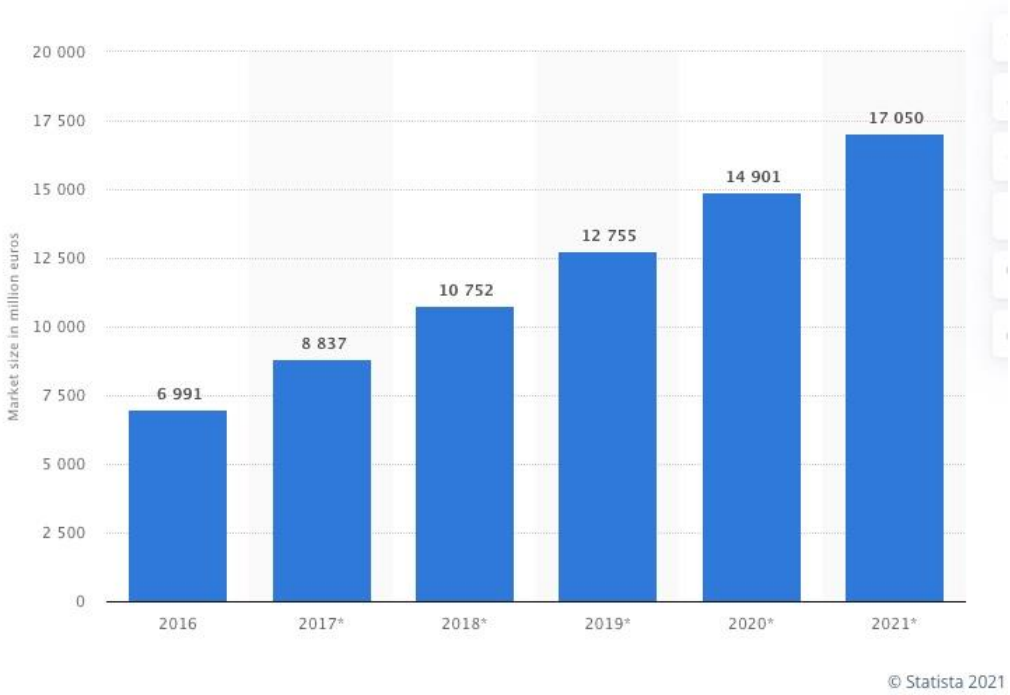



*Figure. The market size of the Internet of Things in the Nordic Countries. Statista 2021.*

[1] Taylor, Charlie (2019). Internet of things adoption on the rise in the Republic. *The Irish Times*, 22/4-2021. https://www.irishtimes.com/business/technology/internet-of-things-adoption-on-the-rise-in-the-republic-1.3867645

The interest in IoT in public sector organizations has increased during the last decade, especially in relation to the trend of the smart city concept. (Velsberg et al 2019)[2]. In 2018 there existed 367 projects in the area of smart city and the majority of them (45%) were located in Europe.

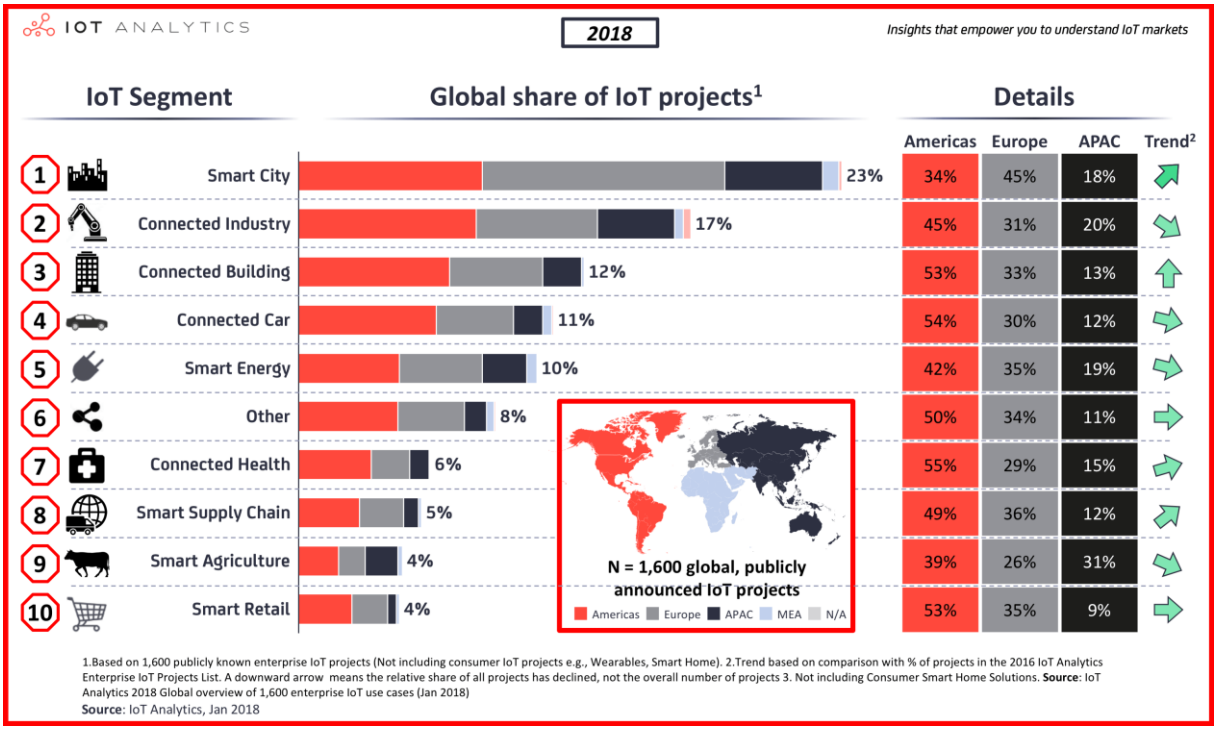



*Figure. Overall ranking of IoT projects. Source: IoT Analytics. [https://iot-analytics.com/top-10-iot-segments-2018-real-iot-projects](https://iot-analytics.com/top-10-iot-segments-2018-real-iot-projects).*

The most common use case in the smart city concept is "connected public transport" that provide smart systems to the citizens so they can commute easier and more reliably with public transport. Other examples of current IoT solutions that are used worldwide are traffic monitoring and management, water level/flooding, video surveillance and analytics, connected streetlights, weather monitoring, etc.

[2] Velsberg, Ott et al (2020). IoT Triggers: How municiplaties are transforming to smarter cities through IoT use. *Scandinavian Journal of Information Systems*.

The most popular use cases in cities trying to become smarter are listed below.

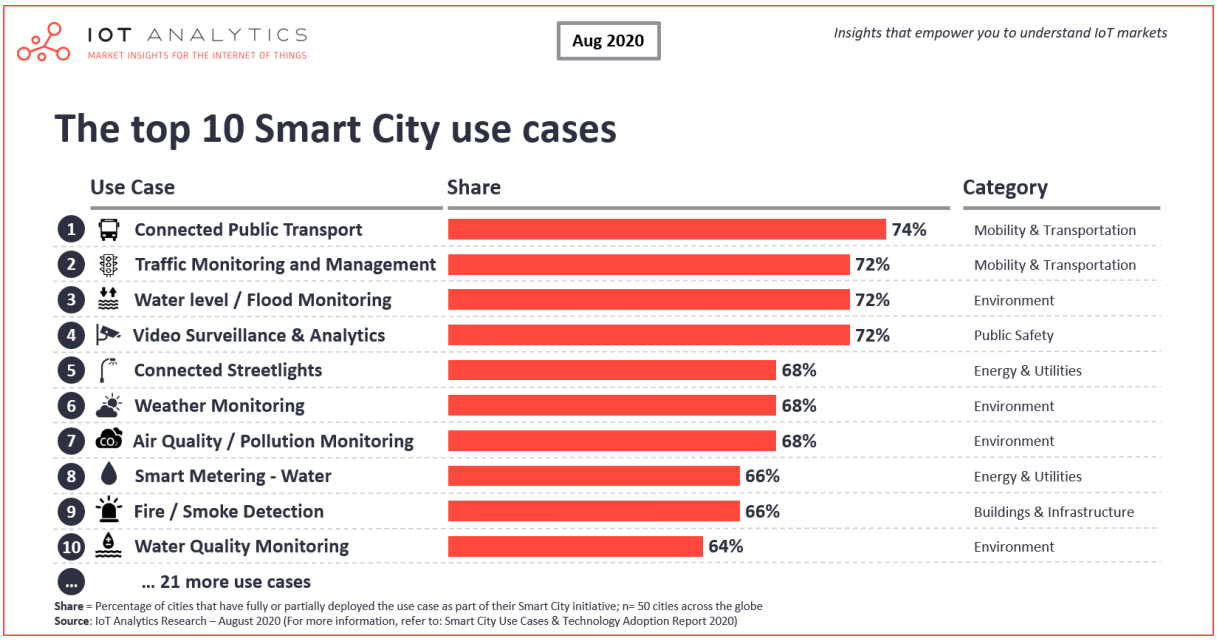



*Figure. Top 10 Smart City use cases. [https://iot-analytics.com/top-10-smart-city-use-cases-prioritized-now/](https://iot-analytics.com/top-10-smart-city-use-cases-prioritized-now/).*

## Application domain of IoT in NPA countries

Findings from earlier studies from Northern Europe shows that IoT is used especially in relation to the concept of smart cities and within seven different application domains; a) Transportation and infrastructure, b) Utilities and environmental monitoring, c) Buildings, d) Care and support, e) Crime and disaster prevention, f) Culture, tourism and sports, and g) Education. The most common usage and the major application area was in transport and infrastructure sector, followed by utilities and environmental monitoring and care and support. Examples of IoT solutions in transportation and infrastructure were street lightning, parking sensors, fleet telematics, pedestrian/cyclist counter and remote passenger validation systems. In the application domain of utilities and environmental monitoring the following application areas appeared; air quality sensors, garbage bins, noise sensors, temperature sensors, water meters and in wastewater treatment plants. Examples of IoT in care and support was asthma inhalers, glucose meters, medical bracelets, smart door-locks, training tracker, etc. In education settings attendance recording systems, and IoT solutions that improved safety and encouraged student engagement was used.

The above uses of IoT accord well with a literature review that examined research articles that dealt with different IoT domains.

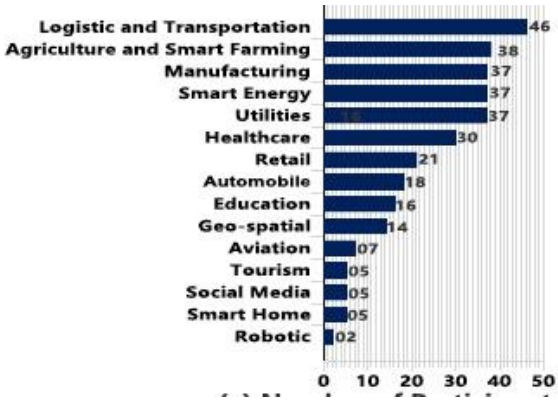



*Figure. Number of authors and their professional domains in IoT articles*.[3]

The E-Government Index (EGDI) and Digital Economy and Society Index (DESI) which measure the level of 5G and possible IoT infrastructure shows that Norway (0,855 and 64), Finland (0,881 and 68), Sweden (0,888 and 65) Denmark (0,915 and 70), Iceland (0,830 and 62), and Ireland (0,828 and 60) are in the top tier of digital economies in EU (EU average 0,724 and 50). The European region is far above the world average of 0.55.

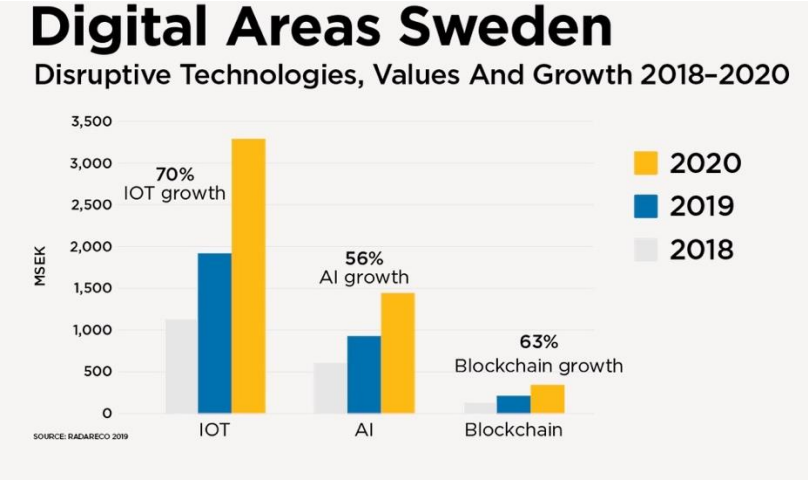



*Figure. Growth of disruptive technologies in Sweden*

[3] Fahmideh, M et al (2021). Software Engineering for Internet of Things. *IEEE Transactions on Software Engineering*.

## Examples of IoT use within the NPA region

- **In Sweden there are currently (2021) more than 50 strategical IoT projects funded nationally**. Among those are 11 within Health, 16 in city planning/environment and 2 in Education. In their government plan Norway has the objective to deploy a nationwide 5G network by 2023 with the purpose to leverage different IoT solutions. The Artic University of Norway in Tromsø have been experimenting in a project, E8 Borealis, where they tested positioning equipment for self-driving cars, trailer-platooning and safety solutions on the road from Skibotn to Kilpisjärvi. Together with Telenor they have also worked in a project called smart house. The house is built for an elderly person, and uses sensors, smart devices and voice control systems that completely rely on Internet and IoT.
- **In Rovaniemi, Finland they have established the concept of Arctic smart village, Älykylä**. The concept envision energy-sufficient solutions, ecological housing, and the idea of sharing economy and collaborative consumption. Rovaniemi has for almost 20 year used advanced technologies, as they already in 2000 started a project called Street Doctor that uses modern digital technologies to provide information about the street network conditions and its trends for Rovaniemi engineers and city decision makers. (Cartaxo et al, 2021)
- **Ireland has been involved in the semiconductor and microprocessor industry for over 30 years and is also involved in the area of IoT**. Companies such as SAP, Intel, IBM, EMC, Movidius, Grasp, etc. are heavily involved in the movement Smart Ireland. This evolution has also made an impression on National Geographics that recently named Dublin as the capital of Internet of Things. Among IoT projects that can be mentioned is Smart Bay a test bed in Galway that is a collaboration between IBM and the Marine Institute.
- **A health application from Iceland that deliver Covid-19 vaccine is another IoT example**. The company Controlant has a real-time supply chain monitoring system that involves screen-based IoT tags connected to GSM networks that are used for distributing mRNA-based covid-19 **vaccine.**

### IoT strategies

The public authorities' objectives to implement and use IoT solutions varies between different local governments and are characterized by four distinct areas. Firstly, financial aspects are a common driver for IoT use among local governments where cost savings and efficiency are key aspects. Efficiency is rather broad term and can be interpreted as to both reduce cost and waste. Secondly, the aim of using IoT solutions is often to develop data-driven value creation towards citizens. IoT can here provide data both for decision-making and data that can be visualized to improve public services for different stakeholders. Thirdly, in most local governments structural changes are required since these organizations have little knowledge of both governing IoT-projects and developing solutions based on for instance automating services and remote monitoring. A consequence of this is that most local governments need to collaborate with external partners with knowledge resources such as private enterprises or universities with the aim of building internal capabilities for understanding the technology. Fourthly, some local governments used IoT to show that the organization were an early technology adopter that is innovative, future-oriented and digitally competent.

## 3.2 Artificial intelligence in public sector – NPA Outlook

This section provides an outlook at of the current situation in relation to the adoption of artificial intelligence in the public sector in the NPA countries. The info presented takes as a basis the study AI Watch - Artificial Intelligence in public services[4] published in 2020. This report is published in the context of AI Watch, the European Commission knowledge service to monitor the development, uptake and impact of Artificial Intelligence (AI) for Europe.

This study aims to shed lights on the actual use of AI technologies in the public sector, providing a review of AI adoption in public services in all 27 EU Member States, as well as Norway, Switzerland and UK, and building a first inventory of 230 cases that represents a unique reservoir of knowledge, from which to extract indications, emerging trends, and illustrative examples of current AI usage. It also includes a review of the AI national strategies of EU Member States, to assess the focus on public sector, and showing that most countries are taking several actions to stimulate the use of AI in their public services.

[4] AI Watch - Artificial Intelligence in public services

## Technology perspective

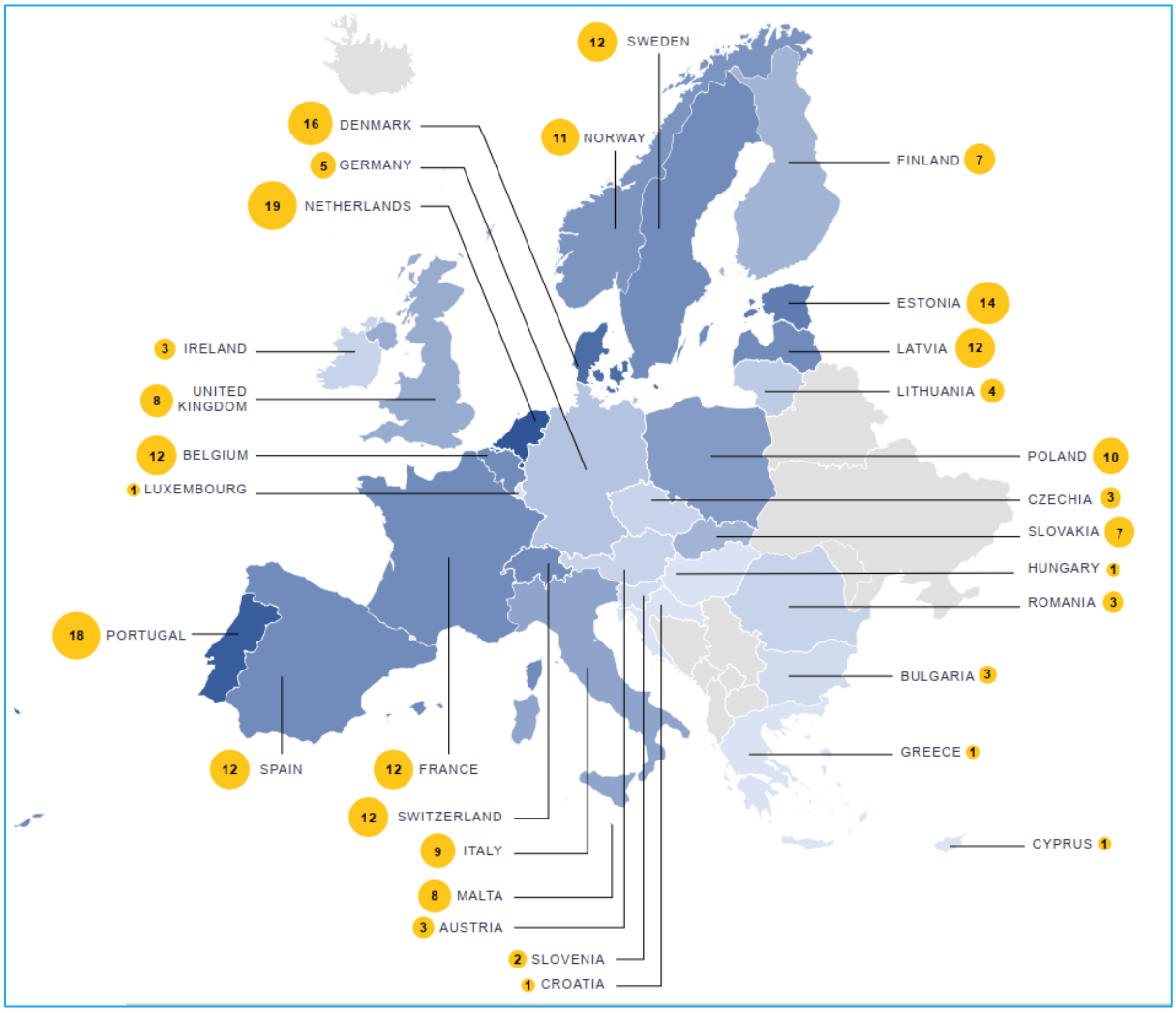
Technology wise, this report proposes a classification based on 10 application domains – called 'AI typologies'.

The observed number of cases in the European public sector shows an interesting variety among:

- A relative majority (22% of the cases) of 'Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems';
- An interesting number (15% of the cases) of applications in the domains of 'Predictive Analytics, Pattern Recognition Simulation and Data Visualisation';
- Other two typologies, both of the same size (12% of the cases each), which are related on the one hand to 'Computer Vision and Identity Recognition' and on the other hand to 'Expert and Rule-based Systems, Algorithmic Decision Making'.

Taken together, these four AI typologies constitute about two thirds (143 of 230) of the current database under investigation and therefore communicate a clear orientation of the surveyed initiatives in terms of adoption.

The AI Watch has collected, during the period May 2019 – February 2020, a set of 230 initiatives using AI in public services across the European Union, as illustrated in the map below. It is to be noted that this inventory is based on the use of AI in public services by government agencies, which had the consequence of not gathering AI use cases used for the public good but provided (solely) by private actors, without collaboration with government actors. In fact, there are many exciting AI applications made available in the social domain by private organisations – especially in public health services or transportation – which have fallen outside of the scope of this inventory. In addition, it must be stressed that the current inventory is by no means a representative sample of the current use of AI in government due to biased data collection methods to obtain the current inventory.




*MAPPING THE USE OF AI IN PUBLIC SERVICES ACROSS EUROPE (Source: AI Watch – Artificial Intelligence in Public Services)*

## Application domain of AI in NPA countries

**NPA countries monitored (Ireland, UK, Norway, Sweden and Finland)** present 41 AI-driven solutions. This amounts almost 20 % of the overall examples collected. Sweden (12) and Norway (11) are among the countries with higher number of solutions presented.

The areas addressed in DISTINCT present the following number of initiatives:

- **Health: 41initiatives (18%)**, 12 of them from NPA countries
- **Environment: 3 initiatives (1%),** none of them from NPA countries
- **Training/Education: 7 initiatives (3%),** 1 from NPA countries

Regarding the area of application, the most recurrent functions are General Public Services (with 76 cases), Economic Affairs (with 40) and Health (with 41). All of them, and especially the former two, are typical examples of central government functions.

Areas addressed in DISTINCT have been selected of high importance by the respondents from the member states:

- Health (4.6/5 level of importance)
- Education (4.4/5 level of importance)
- Environmental Protection (4/5 level of importance)

## Examples of AI use within the NPA region

- **Derry and Strabane District Council in Northern Ireland, has implemented the Zero waste circular management service** to change public behaviour towards achieving a zero-waste circular district. The service particularly will: 1) Improve accessibility to sustainability information for members of the public and businesses, including those in peripheral areas; 2) Improve communications on Waste and Recycling services through digital offerings; and 3) Better deliver the service to the public with reduced staff overheads (reduced number of calls into agents).
  This service uses chatbot technologies providing an online response service on information regarding waste, bin collecting, recycling services, etc. 24 hours a day 7 days a week. It is also aimed at helping people report issues more easily and freeing council staff from dealing with mundane enquiries concentrating instead on more complex questions.
- **The Regional Council Västernorrland in Sweden, has implemented the Green growth advisory services** to assist advisors in their task of providing advice to the community to be more energy efficient and solve the issue they have to reach a wider audience.
  In particular, the new service uses chatbot technologies to: 1) Improve communications on energy and climate with businesses and the general public; and 2) Improve the public awareness of the available services, grants and overall efficiency of different energy options. Currently, this service is delivered via phone calls and face to face meetings with part-time advisers and thus limiting its availability.

## AI strategies

By June 2021, 20 Member States and Norway had published national AI strategies, while 7 Member States were in the final drafting phase. The figure shows an overview of national AI strategies in the EU Member States and Norway (Source: JRC – European Commission).

| Country | Status | Date |
|---|---|---|
| Austria | In progress | |
| Belgium | In progress | |
| **Bulgaria** | Published | Dec. 2020 |
| Croatia | In progress | |
| **Cyprus** | Published<br>Last update | Jan. 2020<br>Jun. 2020 |
| Czech Republic | Published | May 2019 |
| Denmark | Published | Mar. 2019 |
| Estonia | Published | Jul. 2019 |
| **Finland** | Published<br>Last update | Oct. 2017<br>Nov. 2020 |
| France | Published | Mar. 2018 |
| **Germany** | Published<br>Last update | Nov. 2018<br>Dec. 2020 |
| Greece | In progress | |
| Hungary | Published | Sept. 2020 |
| Ireland | In progress | |
| Italy | In progress | |
| Latvia | Published | Feb. 2020 |
| Lithuania | Published | Mar. 2019 |
| Luxembourg | Published | May 2019 |
| Malta | Published | Oct. 2019 |
| Netherlands | Published | Oct. 2019 |
| Norway [AC] | Published | Jan. 2020 |
| **Poland** | Published | Dec. 2020 |
| Portugal | Published | Jun. 2019 |
| Romania | In progress | |
| Slovakia | Published | Jul. 2019 |
| **Slovenia** | Published | May 2021 |
| **Spain** | Published | Dec. 2020 |
| Sweden | Published | May 2018 |

*Note: Ireland has published its National AI Strategy on 8th July 2021.*

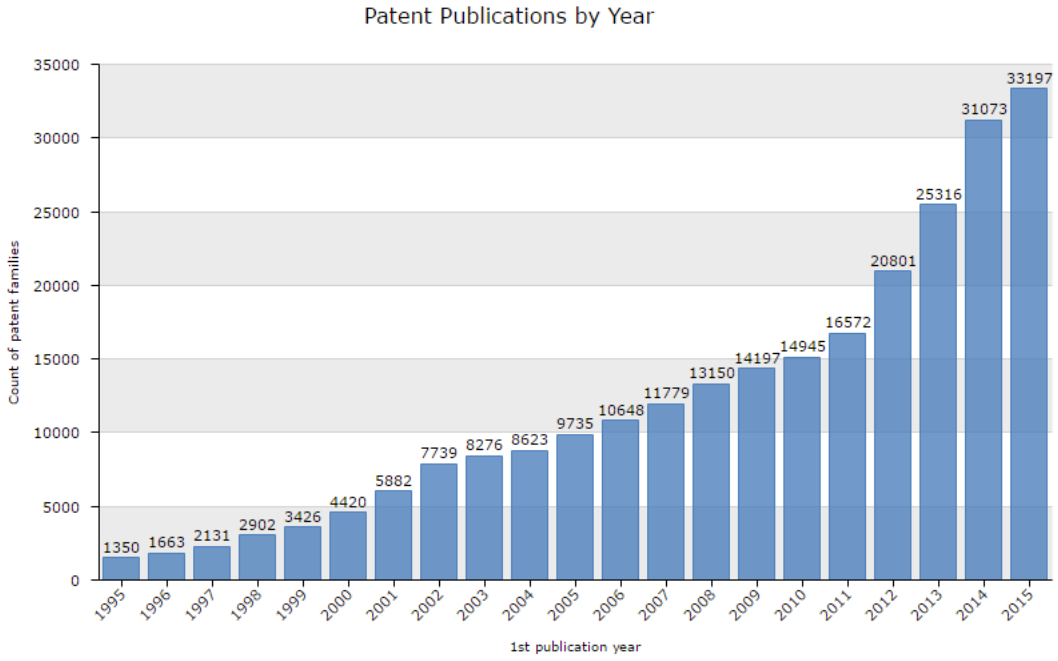
# 3.3 VR/AR in public sector – NPA Outlook

This section reports the use of Augmented reality (AR) and virtual reality (VR) within public sector organizations in the NPA region. Augmented reality (AR) and virtual reality (VR) are distinct technologies that could be conceptualised on a spectrum spanning reality to virtuality. According to an interviewed industry expert, there is no established and widely accepted definition of VR/AR, due to the rapid developments occurring in the VR/AR technology landscape. Broadly speaking, AR and VR can be defined as follows:

- **Virtual reality (VR)** is a computer-generated scenario that simulates a real-world experience. A more simplified definition of VR as a technology that allows people to 'experience a computer-generated virtual environment'. This definition thus recognises the potential of VR in immersive simulation of a real-world experience in the gaming industry and beyond.

• **Augmented reality (AR)** combines real-world experience with computer-generated content. When the recent advances in smartphone technology are considered, definition of AR as a technology 'that allows computer-generated virtual imagery information to be overlaid onto a live direct or indirect real-world environment'

Rather than be considered as two distinct technology outcomes, VR and AR should be seen as part of a spectrum of outcomes that span from reality to virtuality. An additional term used in conjunction with VR and AR is **mixed reality (MR). Mixed reality is described as the 'merging of the real and virtual worlds, meaning that virtual objects are "anchored" to the real environment as opposed to "simply" overlaid'** (European Commission, 2017).




The above chart shows the number of new patent applications directed specifically to AR and VR technologies that were filed each year from 1995 through 2015. (Source: Augmented and virtual reality: emerging legal implications of the "final platform". Reed Smith LLP, 2017.)

## The EU Policy environment: shaping Europe's VR and AR future

According to the Virtual reality and its potential for Europe report (Ecorys 2017)[5], the European Commission supports European researchers and entrepreneurs to help scale up the ICT innovation ecosystem in Europe by reinforcing actions for ICT innovation through Horizon 2020 (the EU Research and Innovation programme) with nearly €80 billion of funding available for the time period 2014–2020. Horizon 2020 also supports SMEs through a new dedicated €2.8 billion SME Instrument, which is targeting innovative SMEs. Open Disruptive Innovation is a scheme under this SME Instrument, which aims to support fastgrowing, innovative SMEs with close-to-market ideas bearing

[5] Virtual reality and its potential for Europe, Ecorys 2017

high disruptive potential. Additionally, other SME support initiatives are available through the European Commission.

Despite the many strengths of the VR and AR industry in Europe, there are certain issues that will need to be addressed in order for Europe to become a powerful player in the global VR and AR industry. Based on an extensive consultation with VR players in Europe, various challenges have been identified that have an impact on the growth of the European VR landscape. These include:

- A lack of risk funding as well as a pro-risk and experimentation mentality in general.
- Weak links between research and the market.
- A lack of cooperation across the different countries in Europe.
- Current and expected needs for adequate infrastructure and resources.

## VR/AR in the public sector

Recent technological developments, underpinned by the growth of the internet, have implications – both positive and negative – for a range of sectors and stakeholders. However, while the potential implications are wide-ranging, they are not necessarily predictable, linear or deterministic. Developing a better understanding of the implications of the complex issues associated with technologies is therefore of critical importance for governments, policymakers, businesses, academia and citizens.

Incremental progress in technology could be expected to result in various economic and societal changes. However, technologies termed 'disruptive' or 'game-changing' are those transformative technological innovations with the potential to significantly reshape the way society does things, whether these be business and organisational practices or more generally associated with everyday life.

Technologies related to Mixed Reality and co. are already being used in many fields. Things can not only be made to "come alive" in the gaming and entertainment industry, or in marketing, but also in aviation, for the training of pilots, in the education and publishing industry for displaying the content of books, or in medicine, in operations, and also to provide life-changing support regarding the visual perception of individuals who suffer from visual impairment.

The possible applications for Mixed Reality are limitless. Particularly in connection with artificial intelligence and in the context of the recognition of people, objects, or language, it is not just the user experience that is being taken to the next level, but more and more Use Cases are also being facilitated. With enormous amounts of data and new analysis approaches, algorithms that explain behaviours can enable a multitude of new business models in the virtual world in the future.

## VR/AR in education and training

According to an interview with an European researcher, educational services in schools, higher education and businesses could benefit from VR/AR by providing realistic, contextual, on-site learning experiences in classroom-based settings to test knowledge and problem-solving skills. Driving school instructors could also use devices using mixed reality to expose students to simulated driving scenarios that may be too complex or dangerous to experience in real life. Similarly, VR simulations of training in fire services could reduce risks of exposure to hazards that could cause injuries and deliver a more cost-effective method of training.

A possible advantage of conducting training in simulated VR environments is that it allows employers to create training programmes without the constraints of real-world environments, such as cost, machine availability or safety concerns.

AR-facilitated training programmes typically use AR for memory cues that are superimposed on real environments in situ. Students and workers can be guided through tasks using step-by-step AR-supported tools that can help to improve productivity with limited requirement for prior training. Visual checklists and on-demand instructions along the users' field of vision on the job can also augment experiential learning processes and reduce the risk of error, particularly during times of fatigue or extreme stress.

Multiple players have been offering Augmented Reality (AR) and Virtual Reality (VR) in the education sector. In January 2021, the world's first educational virtual reality theme park was opened. The park consists of six educational Virtual Reality (VR) areas, covering different aspects of the educational curriculum. By using a web-based learning platform, students can consolidate and review what they have been learning during their virtual visit.

Next to the existence of virtual theme parks, the VR@School project, which was derived from the Erasmus+ programme, aims to promote the use of VR in European classrooms. The project's goal is to produce and market a virtual classroom and use VR to innovate and add value to education. The use of VR can help students feel to immersed in an experience, delivering interactions that are either not practical or not possible without VR, like experiencing historical events or doing a scientific experiment. Adding VR to the traditional way of teaching enhances and extends the way in which students can learn and develop.

According to the VR@School project, the use of ICT in teaching and learning activities in the EU is currently applicable to about 50% of students, whose teachers use ICT in a minimum of 25% of their lessons. To further develop and market the use of VR in classrooms, the education system needs a deeper connection with digitalisation and the capacity to develop new learning programmes that involve VR.

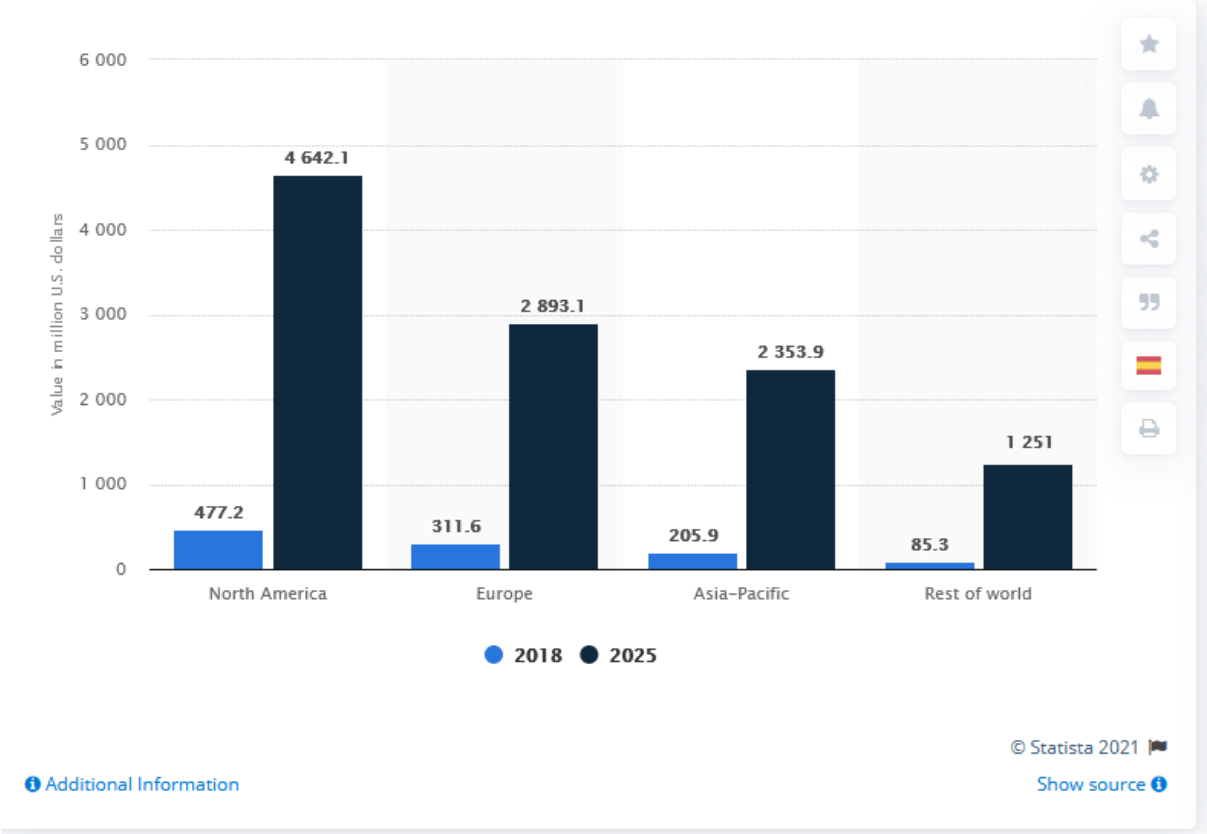
Source: Advanced Industry for Technology (ATI) project.

## VR/AR in Healthcare

Europe augmented reality and virtual reality market in healthcare industry accounts for $507.61 million in 2019 and will grow at a 2019-2026 CAGR of over 36%, representing the second largest healthcare AR and VR regional market in the world.

Many VR companies and research institutes aim to enhance the medical sector. Already a number of medical trainings are available and are widely adopted by universities and hospitals. Apart from trainings, VR can also be used to enhance interdisciplinary communication as well as directly for the treatment of patients.

In the medical sector, especially VR is used in many ways. It is used in psychotherapy, pain reduction, rehabilitation, and education.




*Global healthcare AR and VR market in 2018 and 2025, by region (in million U.S. dollars) - Statista*[6]

### Psychotherapy

Virtual Reality solutions provide new tools for psychotherapy disorders. These include post-traumatic stress disorders (PTSD), phobias, anxiety disorders and other cognitive behavior disorders. In some cases, VR applications provide new tools for psychotherapy treatments that has not existed before.

[6] Global healthcare AR and VR market in 2018 and 2025, by region

The current treatment guideline for phobia and post-traumatic stress disorder are cognitive behavior therapy, exposure therapy and EMDR-psychotherapy with proper medication, if the conditions are severe.

Post-Traumatic Stress Disorder, Phobia Treatment, Cognitive Behavior Therapy for Children with Autism.

**Pain Reduction**

The Virtual Reality could be a great tool to turn pain focus away using visualization, sound, olfactory and sensory feedback. One assumption for VR analgesia's function is a gate theory. The idea is that the more different stimulus and senses sent to the brain closes the gates for a person to focus to pain stimulus. This way the patient would be feeling less pain.

Another aspect for Virtual Reality during the clinical treatment, is that the patient doesn't see the actual treatment care happening. This usually creates strong anxiety towards the procedure that is been accomplished. Using a HMD to block out these visual expectations, can help to reduce pain feelings.

Burn Wound Patients, VR Analgesia for Chronic Pain

**Rehabilitation**

VR rehabilitation covers stroke's physical and neurological training, and also VR rehabilitation for different addictions, alcohol, drugs, smoking, eating disorders and others.

**VR Simulation and Education**

Simulation Based Training for Mass Disaster, VR Anatomy Education, Therapist Training and Virtual Patients, and Surgery (Surgical Training and Surgery Planning)

## VR/AR in environmental planning

The question also arises for CIOs and IT professionals in the public sector as to which initiatives should be taken and which technologies and platforms should be invested in if they want to strategically advance digital applications with Mixed Reality.

In addition to spatial and environmental planning, e.g. for museums, sports facilities, neighbourhood centres, and playgrounds, displays and Smart Glasses can also facilitate decision-making in urban planning tasks. To master the challenges that come with the overhaul of the infrastructure offering and to consider the equality of all those involved in the entire planning process, planning innovations are required. Mixed Reality provides the opportunity for so-called Gender Planning to visualise different

scenarios or different life situations and interests, and to thus assist in decision-making, e.g. regarding streetlights.

### Examples of VR/AR use within the NPA region

- **In Ireland, The National University Ireland Galway (NUIG) hosted the first Irish virtual reality classroom.** Using Altspace VR by Microsoft and using Oculus headsets by Facebook Engineering, they connected students with Insight researcher.
  The session involved a researcher from NUIG presenting their topic to students in an understandable way in a virtual classroom. This is followed by Q&A which is again followed by a museum tour, research posters on climate exploration, Data Muses, space exploration of data and original pieces of art made by researchers and finally another presentation on data and music.
- **In South Savo (Finland)** an **augmented reality powered app is being used to place correctly place the light poles**.
- **The HUS VRLab in Finland** is a showroom where visitors can try XR solutions that are developed for healthcare.

## 3.4 Blockchain in public sector – NPA Outlook

This section is aimed to provide an outlook at of the current situation in relation to the adoption of blockchain in the public sector in the NPA countries. The recent emergence of this technology and its scarce application in the public sector so far makes impossible to find a comparison framework in at European level. For the purpose of this report we will provide information about the role that this technology can play in the public service provision and show some examples of application in the NPA area.

### Blockchain for digital government

According to the Blockchain for digital government report from the EU Joint Research Centre[7], digital government is the state-of-art paradigm in public administration science. The former, much narrower, concept of e-government acknowledged the role of digitalisation as an input or enabler of modernisation of the public administration. Digital government takes a step ahead and focuses on the provision of user-centric, agile and innovative public services. These services and service

[7] Blockchain for Digital government report from the EU Joint Research Centre

delivery models should leverage digital technologies and governmental and citizen information assets. Blockchain definitely is the one of the most innovative digital technologies that has to be considered under the new paradigm of governmental policy making and service delivery. The main benefits of applying blockchain technology in governments are claimed to be:

- Reduced economic costs, time and complexity in inter-governmental and public-private information exchanges that enhance the administrative function of governments.

- Reduction of bureaucracy, discretionary power and corruption, induced by the use of distributed ledgers and programmable smart contracts.

- Increased automation, transparency, auditability and accountability of information in governmental registries for the benefit of citizens.

- Increased trust of citizens and companies in governmental processes and recordkeeping driven by the use of algorithms which are no longer under the sole control of government.

In the context of digital government, blockchain technology has a potential of facilitating direct interactions between public institutions, citizens and economic agents. At the most basic level, this implies improved public services in information registration and exchange processes. Blockchain technology is a combination of several existing, but distant, technologies that form a new decentralised information infrastructure. Decentralisation of blockchains is the core feature that can reshape the way governments interact with citizens and with each other (Atzori, 2015). Blockchain technology could take away a large part of the administrative tasks that governments fulfil in society nowadays. Governments possibly do not have to provide, on their own, information storage and information exchange processes in order to facilitate economic activities in societies, as this could be provided by blockchain protocol. Instead, they should maintain a supervisory role with regards to the transactions taking place in this infrastructure.

Blockchain technologies can potentially be used as an information infrastructure for exchanging information between public administrations. For example, timely and reliable exchange of criminality information, the distribution of grants and the exchange of information regarding academic degrees or taxes could be facilitated by blockchain (Davidson, De Filippi, & Potts, 2016). Distributed registration of documents and assets, instead of solely registering in a centralized way, is argued to bring several technical and economic advantages. Greater transparency, reliability and improved performance are in particular important when applications require data from multiple sites, organizations or countries. On the contrary, the distributed nature of blockchain systems is expected to create uncertainties regarding the stability in the network, as it removes one point of control. For example, whereas in the banking system banks act as centralized intermediaries in control of the system, in a blockchain-based system the power in the network is distributed among all the participants. Decentralisation is, to a certain extent, challenging, as it is incompatible with institutional structures of governments, corporations and marketplaces, as we

known them today. Therefore, especially governments should consider the governance and organizational impacts of blockchain implementations, given their fundamental differences with traditional information infrastructures. It is argued that in order to fully harness the potential of blockchain in the public sector, administrative processes and governmental structures will have to be re-engineered to adapt to the technology and not the other way round.

Blockchain technology is also promising from the citizen-centric perspective. In particular, citizens can experience economic benefits and efficiency gains from services that leverage smart contract automation or notarization, such personal certificates or land titles issuance (Atzori, 2015; Norta, 2015; Swan, 2015; Van Zuidam, 2017). Moreover, services drawing on decentralised nature of blockchain, such as identity or voting, change a balance of power, increasing the ownership and control of citizens over democratic processes.

Given all these benefits and challenges, blockchain technology can disrupt the status quo in the public sector. Blockchain can bring efficiency by spanning siloes, flattening tiers and inspiring new service delivery models for governments. The architectural set-up of blockchain can also reduce operational risk and transactional costs, increase compliance and increase trust in government institutions. However, the lack of mature, stable, commercial platforms, some gaps in essential functionality (e.g., smart contracts) and the lack of actual implementations within government indicate that this technology has yet to mature. Challenges often recognized are scalability, governance, flexibility and implementation styles.

### Policy context

The relevance for the EU has been publicly recognized over the last years by the European Commission (EC) and the European Parliament (EP). In order to "highlight key developments of the blockchain technology, promote European actors and reinforce European engagement with multiple stakeholders involved in blockchain activities" (European Commission, 2018c), the European Commission has launched the EU Blockchain Observatory & Forum. In addition, the EC has been funding blockchain projects through research programmes FP7 and Horizon 2020 since 2013, and projects can be funded up to 2020 with funds accumulating to €340 million. For governments, the EC has identified the following use cases (European Commission, 2018d):

- Citizens' ID management;
- Taxation reporting;
- Development aid management;
- eVoting;
- Regulatory compliance.

Recognizing that blockchain technology may bring great improvements for Europe, not only for the private sector but also for the public sector, the EC and the EP believe that blockchain enables the provision of more efficient and new services by:

- The improvement of business processes for governmental actors at any level of government;
- Enabling new distributed business and interaction models for citizens without centralized platforms, intermediaries or institutions (European Commission, 2018b);
- The creation of fast, cheap and especially secure public records (Boucher, 2017).

In addition, blockchain systems could also facilitate the Once Only Principle (OOP) announced by the European Commission in eGovernment Action Plan for 2016-2020 (European Commission, 2016). The OOP mandates that citizens, public administrations and companies must only enter information once to access public services across the EU. Shared, decentralised database of credentials presumably could provide a technical solution for the OOP and hence contribute towards increasing the efficiency of the Digital Single Market.

As stated in the European Council conclusions of 19 October 2017, blockchain is a key emerging trend that the European Union should foster, while "ensuring a high level of data protection, digital rights and ethical standards" (European Council, 2017) The European Union agrees about the potential of blockchain technology to enhance the effectivity of digital governments and regards blockchain technology to have the potential to be a key backbone component of a world-class trusted data economy infrastructure. To foster innovation in this area, the EU should focus on setting the right conditions and boundaries for developing blockchain technology that digital governments can use to provide, open, trustworthy, transparent and compliant public services. In order to define the right approach for identifying those conditions and boundaries, a deep dive into the current state of play is needed. The current report attempts to fill this knowledge gap.

## Examples of blockchain use within the NPA region

- **In Sweden, Luleå University of Technology is working in the Secure information flow project to develop a digital platform for trading in solid biofuels** that is used by a significant proportion of market participants.
  The project will also look at whether blockchains can be used to meet users' demands for safety, traceability and integrity in digitalised trade in biofuels in Sweden**.**
- **Norwegian start-up Diwala has created a platform that created a platform,** that enables educational institutions and organisations to safely and digitally issue and verify credentials, backed by blockchain technology.
- **The Finnish Immigration Service have been using Moni, a unique digital identification on blockchain to give asylum seekers prepaid Mastercard's.** MONI's technology allows blockchain to act like a simple debit card and convert digital currency.
- **Iceland's data center industry such as Advania, has expanded rapidly,** where they offer space to Bitcoin miners, supercomputer capabilities etc.

# 4 NPA organisations expertise in disruptive technologies

The DISTINCT partnership has gathered information about the existing expertise from organisations/departments within the NPA area. This information, which focuses around the 4 disruptive technologies (IoT, AI, VR/AR and Blockchain) and service areas of health and social care, environmental management and training, includes concrete examples of application.

The following map shows the main figures and the NPA countries where expertise has been mapped.


If we focus per technology the following initial conclusions can be extracted.

## Internet of Things (IoT)

There is a significant knowledge and a good level of maturity when it comes to its application in the delivery of services. If we pay attention to it per service area the following facts arose:

- **Health and social services**: IoT is present to support ambient assisted living (AAL). The type of solutions varies ranging from wearable devices/sensors to monitor patient's parameters to the inclusion of sensors in furniture and other house assets that help patients and elderly in their daily life.

- **Environmental management**: this is an area where IoT is applied in a wide range of services. Apart from monitoring environmental parameters like air quality or temperature, IoT is being used to monitor river levels to detect potential flooding or leakages in sewer systems, in traffic management with IoT cameras, road temperature sensors and traffic counters. Counters also have application to preserve natural heritage sites or other locations considered as high-environmental risk.
- **Training and education**: some experiences have been applied in schools to better manage the learning environment, i.e. by monitoring noise in the classrooms.

## Artificial intelligence (AI)

AI powered solutions are in the process of expansion. In the case of public services provision, they are still in an earlier stage although there are already several examples of application that show the potential that this technology has in assisting public service providers:

- **Health and social services**: AI is being used to decision making processes. For example, doctors are getting assistance by incorporating experience from previous cases. Other application is providing AI-based person-tailored decision support in the form of a digital coach for managing stress, fatigue, and tiredness. AI is also is supporting image recognition processes and creating models in medical research. AI-powered chatbots are also in use to automatize information services.
- **Environmental management**: in this area there AI is being used to assist conversational chatbots in the provision of information about recycling services or providing advise to communities about energy efficiency measures, to name some. Another field of application is the prediction of the risk of icing on the rotor blades on wind turbines.
- **Training and education**: no concrete examples have been identified so far, except to a large selection of courses and programs with focus on AI provided by most of the education providers in the NPA-region.

## Virtual reality / augmented reality (VR/AR)

VR/AR technologies present a significant level of maturity. In the case of the areas addressed in DISTINCT interesting examples of application include:

- **Health and social services**: VR is being applied in different ways ranging from 3D structures of human nervous system, to work with lung pathologies and simulation of stem cell experimentation labs. VR-technology has also been extensively used in surgery.
- **Environmental management**: not too many examples have been identified.
- **Training and education**: VR is being used to create immersive learning environments. For example, as a reaction to the COVID-19 pandemic, some universities are creating virtual reality classrooms allowing students to attend lectures remotely in a fully immersive environment.

## Blockchain

Blockchain is the technology with lower level of application in public services from the ones mapped. The number of examples identified is limited:

- **Health and social services**: no concrete examples have been identified.
- **Environmental management**: blockchain is being used to meet users' demands for safety, traceability and integrity in digitalised trade in biofuels in Sweden.
- **Training and education**: no concrete examples have been identified.

More detailed information can be consulted in the Annex – Organisation profiles.

# 5 Recommendations

The exercise made by the DISTINCT partnership shows that the NPA area holds a significant knowledge and expertise in relation to the disruptive technologies addressed in the project, namely Internet of Things (IoT), Artificial Intelligence (AI), Virtual Reality/Augmented Reality (VR/AR) and Blockchain.

Existing initiatives evidence the added value that these technologies can bring into the provision of quality and sustainable services giving response to the challenges and needs of the NPA communities and territories.

To unlock the potential of this existing knowledge and expertise the following points could be considered:

1) **Awareness raising about the existing expertise and its potential application**
   Disruptive technologies evolve rapidly and make difficult for the public sector and communities to know and understand the change they can make in our daily life. Actions aimed to show these possibilities, if possible, by showing real cases of implementation, can make a difference and be turn into a more **receptive position for their adoption.**

2) **Closer collaboration between universities, research centres, companies, public sector and community**
   A closer collaboration between these actors would contribute to better address the real needs and challenges that the public sector and their communities face. The facilitation of a discussion framework where the service providers (universities and companies) can get a direct input from them would be translated in more concrete solutions shaped to these current needs and challenges.

3) **Skills provision**
   The adoption of disruptive technologies brings together the need of upskilling the workers of the public sector who are in charge of the delivery of the services and the final users to be able to take advantage of the use of these new

technologies. The knowledge providers (universities and companies) must supply these required skills.

4) **Early adopters/local champions**
   Initiatives supporting and facilitating the implementation of solutions by early adopters can serve to showcase the benefits of using these technologies. Early adopters can become local champions and serve as catalysers to scale up and expand the use of these technologies.

5) **Revision of digital strategies that take into account the potential of disruptive technologies**
   Disruptive technologies bring with them new infrastructures and devices that need to be managed in relation to existing legacy systems. An understanding of realizing what is needed and how to utilize the potential is therefore an important component in digital strategies and policies.

6) **Make aware and open up existing testbeds and labs for disruptive technologies**
   In the NPA-region we can find a large number of service providers (universities and companies) that have testbeds and labs (see appendix). These assets could in a higher degree serve as a driver and ignite an increase of exploration and tests of unique challenges and conditions.

# 6 Annex – Organisation profiles

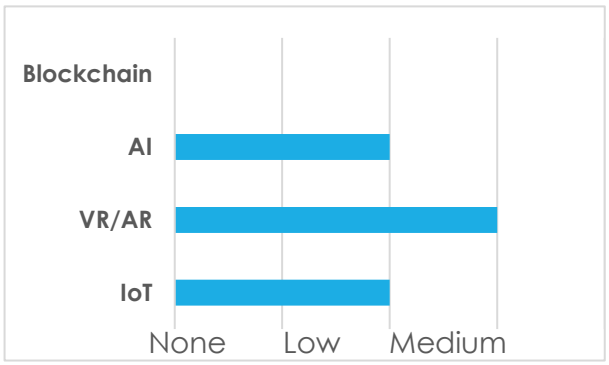
# FINLAND

# KARELIA UAS

## Profile

Karelia University of Applied Sciences (UAS) operates in seven study fields offering 21 programmes out of which five are master-level studies. The study areas are health care and social studies, business, engineering, forestry, media and hospitality management.

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☐ Health and social care
- ☐ Environmental management
- ☒ Training
- ☐ Other:

## EXAMPLES OF APPLICATION

- Use of AR in Teaching

## Contact

**COUNTRY: Finland**

**REGION: North Karelia**

**WEBSITE:** www.karelia.fi/en

# Use of AR in Teaching

**Problem:**

- Media studies trains media technology experts for companies and the public sector. As an educational institution, it is necessary to meet current challenges.

**Why AR**

- AR combines many media contents: gaming, audio, image, video and animation. It is an excellent tool for teaching.

**Solution:**

- There are not many resources to maintain ones professional skills, but planning study courses can be used to learn something new. The want to learn new things is part of teachers' own professional pride. Therefore when the teacher is willing to learn, the organization provides the financial opportunity to acquire the necessary services for the experiments.

The way Karelia's new adoption in the media: challenges are explored together with the students; the teacher's task is first to give them a kick-start and then through teacher-student cooperation many things are clarified.

- Projects are strongly involved in learning and bringing new things to teaching and activities. They speeded up the investigation and experimentation of things. Trial and error, this strong significance of projects

**Consequences and benefits:**

- AR is now part of media education, somewhat integrated into the social sector as well.
- Having experts for companies can be a challenge, as in Finland, it is relatively early, with smaller districts.

As an example, student made flyer to the Waahto brewery. Waahto Brewery table tent (flyer) has two different objects where are AR content. From the first, only the video starts (30 seconds) and the other opens the 360 panoramic user interface.

# SIUN SOTE

## Profile

Siun sote – Joint municipal authority for North Karelia social and health services. We provide social and health care services in 13 municipalities. We also provide environmental health services and rescue services in North Karelia. The population of the social and health care district is about 166 400. Our over 7500 professionals from different fields work together to offer you high quality well-being services.

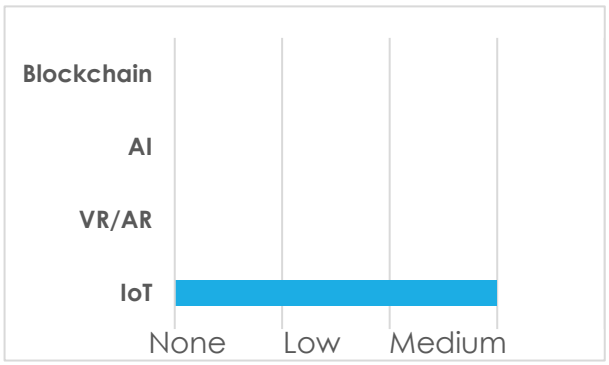
## Contact

**COUNTRY: Finland**

**REGION: North Karelia**

**WEBSITE: www.siunsote.fi**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☐ Environmental management

☐ Training

☐ Other:

## EXAMPLES OF APPLICATION

- Wearable technologies, IoT

# Wearable technologies, IoT

Wearable technology testing was carried out in the SENDoc project. It is an example how how Siun sote and Karelia works closely together, and how Siun sote takes advantage of the NPA-project, https://sendoc.interreg-npa.eu/about-the-project/

**Problem:**

What should the user know? What is measured? What measurement technique is used? Reliability? Repeatability? General activity? Why is it needed? Terms and concepts?

**Solution:**

Phase 1: Efficiency- Can it work? Testing and evaluating sensor systems.: usability aspects and relevant & accurate measures. Comparing with each other measurements of the same area.

Phase 2: Effectiveness – Does it work in practice? Testing and evaluating wearable sensors.

Phase 3: Cost-effectiveness – Is it worth? What can be done with the data?

**Lessons learned:**

A very potential new opportunity to measure rehabilitation / health-related parameters as well

**Objectivity of information**

Society, organization, and end users (clients, therapists).

Rehabilitation is not the most potential target group for technology companies – therefore measuring cost-effectiveness / effectiveness is challenging. Cooperation is needed between companies and practice.

# REGIONAL COUNCIL OF LAPLAND

## Profile

The Regional Council of Lapland is responsible for the strategic entity of regional development in the region of Lapland.

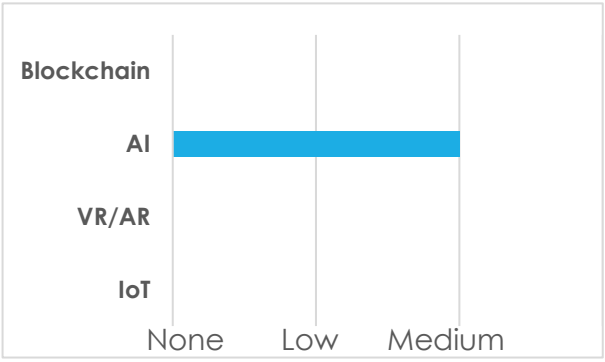
## Contact

**COUNTRY: Finland**

**REGION: Lapland**

**WEBSITE: www.lapinliitto.fi**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☐ Health and social care
- ☐ Environmental management
- ☐ Training
- ☒ Other: Municipal development

## EXAMPLES OF APPLICATION

- Development of municipal financial administration with AI

# Development of Municipal Financial Administration with AI

**Problem:**

Development of municipal financial administration

**Solution:**

Regional Council of Lapland is currently being implemented in sparsely populated municipalities in the automation of financial reporting.

It is currently being studied how Lapland's municipalities can move from manual to automatic reporting, and what changes it requires for each municipality itself. One of the aims is to reform the working methods of the municipalities and consolidate them into practice through peer networks to be created in the project.

# KUAS -KAJAANI

## Profile

Kajaani University of Applied Sciences (KAMK) is an international learning and development community which operates in its own compact campus area. KAMK uses internationalisation as a regional development tool. One profile that cuts through all operations at KAMK, smart solutions, is used to steer all activities. In addition to using technological solutions, smart solutions means the ability to do the right things right.

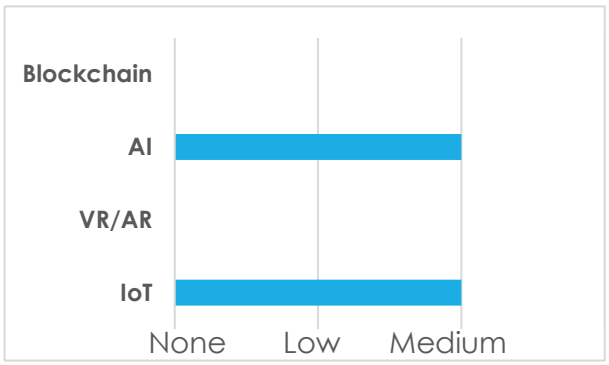
## Contact

**COUNTRY: Finland**

**REGION: Kainuu**

**WEBSITE: www.kamk.fi**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☐ Environmental management

☒ Training

☐ Other:

## EXAMPLES OF APPLICATION

- Measurement and information systems research and development activities
- Modern Data Centre Laboratory

## Measurement and information systems research and development activities

Measurement and information systems research and development activities emphasise sensor to cloud thinking, customer needs initiated working methods and the rapid utilisation of results and data. Our expertise covers the complete information systems chain from measuring to data presentation: 1) the use of sensors and measurement devices, 2) device design and development, 3) measurement technology, 4) data transfer and processing, 5) cloud services and 6) user interfaces.

Our expertise is applicable in a variety of contexts such as wellbeing, health, sports, industry and Internet of Things solutions.

## Modern data centre laboratory

AI (artificial intelligence) solutions, machine learning, data analytics and heavy graphics processing are examples of applications that require high-performance computing infrastructure and specialist service production competence. Our modern versatile data centre laboratory works as a data systems and data centre services development and testing platform for all industries.

# IRELAND

# LETTERKENNY INSTITUTE OF TECHNOLOGY (WISAR)

## Profile

Letterkenny Institute of Technology, through its Wisar Lab holds a wide expertise in IoT.
The WiSAR Lab is a wireless and embedded systems group that provides electrical and electronic solutions for established companies and technology start-ups throughout Ireland.

WiSAR's core strengths are applied to three research strands: The Internet of Things (IoT), Health Monitoring and Industrial Control enabling the delivery of a wide range of product and system solutions across a number of market sectors including manufacturing, health, leisure, agriculture and ICT.

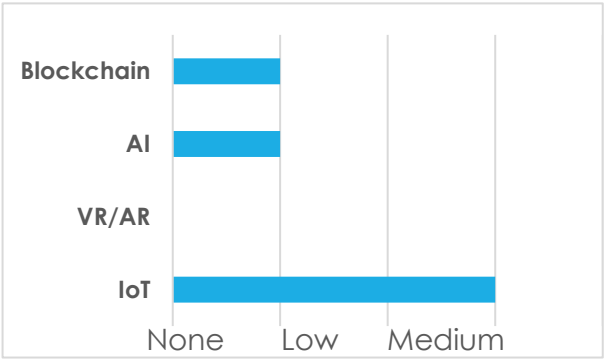
## Contact

**Country:** Ireland

**Region:** Border Midland and Western

**Website:** www.wisar.ie

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☒ Environmental management
- ☐ Training
- ☐ Other:

## EXAMPLES OF APPLICATION

- Pressure seat - Health and social care
- Smart watch – Health and social care
- Dataglove – Health and social care

# PRESSURE SEAT - HEALTH AND CARE

**PROBLEM TO BE SOLVED**

The main problem addressed by this project was the difficulty in monitoring and caring for a large number of patients confined to hospital beds or wheelchairs. The main objective of the project was to develop a monitoring system to reduce and help eliminate the cause of pressure sores and to assist in the early detection and treatment of sores. The proposed system was designed for a large care home or hospital, with the real-time reporting tool allowing the carer to monitor and analyse each patient with individual alerts. The system notifies carers when patients need to have their bodily position changed. The advantage of the system is that it reduces the cause of body sores and consequently helps avoid cases of patient neglect.

**WiSAR SOLUTION**

WiSAR performed extensive research into commercially available pressure mapping/monitor systems and the typical materials used. The outcome of this research was the identification of several pressure sensor fabrics, which were then tested for accuracy and repeatability. The prototype consisted of the development of a pressure sensing mat, wireless data acquisition unit and a wireless base station. The pressure sensing mat was incorporated into an existing wheelchair cushion measuring 15" x 15" and provided a measurement resolution of 1". The wireless data acquisition unit connects via a multi-pin connector to the pressure sensing mat. This unit performs the pressure measurements and then wirelessly streams the results to the wireless base station. The developed prototype can be used as either a pressure monitoring system or a visual pressure mapping system, each system using matching software. WiSAR's role in the project was extensive, starting with the selection and development of the pressure sensing mat, display/monitoring software development, hardware and firmware development of both the wireless data acquisition unit and the wireless base station.

**IMPACT & BENEFITS**

The outcome of the project has been the development of a fabric based pressure monitor system. One of the most important aspects of the development is that since the system's sensing element is fabric it does not affect the user's comfort or the performance of the cushion. The prototype system developed has confirmed the possibilities and the restrictions associated with any pressure monitor system.

# SMART WATCH – HEALTH AND SOCIAL CARE

Annagh Ltd

Annagh Ltd is a start-up company developing wearable devices for people who live on their own and have conditions which limit their independence, e.g. diabetes and epilepsy. The purpose of these devices is to monitor a range of parameters and, by using algorithms within the device, to alert on specific events in order to assist independent living.

**PROBLEM TO BE SOLVED**

Annagh wished to develop a wrist worn device to monitor a diabetic patient which would be capable to alert a friend or carer via a smartphone in the event of a hypoglycaemic event. The company was confident that hypoglycaemic events could be detected by monitoring the patient's heart rate, skin temperature and conductance. The implementation was to allow the user freedom to perform normally daily activities while gathering real data over a long period of time. The project was funded by a series of three Innovation Vouchers and direct funding from the company.

**WiSAR SOLUTION**

Over the course of 3 Innovation Vouchers WiSAR developed hardware, firmware and a basic Android application. The first voucher work was used to develop the base device giving capability to measure skin conductance and temperature and to wirelessly stream these measurements to a PC for later analysis. This was achieved by developing a sensor module and integrating it into the back of a Texas Instruments Chronos watch. In addition, the WiSAR module was used to gather information from a heart rate monitor strapped to the patient and to stream this data to the PC. Voucher 2 was used to add Bluetooth connectivity to the wrist worn hardware and the development of an Android application. Following voucher 1 and 2, the company used the hardware developed to conduct initial trials confirming that it was possible to monitor patients conditions and to then raise an alert if an event was detected. However, during these trials an additional requirement was identified in that it became necessary to store significant amounts of information to support long-term tests. For this reason a third voucher was undertaken to add an SD card storage element in the wrist worn device. This SD card storage allowed Annagh to perform long term tests on patients and to determine if it was possible to detect hypoglycaemic events.

**IMPACT & BENEFITS**

The outcome from the work carried out by WiSAR has been the deployment of a comprehensive prototype which has allowed Annagh to perform field trials and gather real measurements from diabetic patients, which in turn has allowed them to gain a better understanding of hypoglycaemic events. The Bluetooth hardware and corresponding android application gave the company a functional prototype to demonstrate their concept.

# DATAGLOVE – HEALTH AND SOCIAL CARE

Based in the city of Derry in Northern Ireland, ActionSense Ltd, was established in 2015 as a result of a strategic collaboration between academics, clinical specialists in Rheumatology and product development experts. The Company is as a spin-out of Ulster University.

**Dataglove solution**

ActionSense Limited has licensed technology from the University of Ulster for a glove designed to assess the stiffness of the joints in the fingers of patients suffering from various forms of arthritis. The glove works by positioning bend sensors on each finger joint in order to measure joint stiffness. The original proof of concept had overly complex electronics, so the client engaged WiSAR to design a smaller lower cost version. This required the development of a control unit, to be placed on the wrist, which collects data from each bend sensor and sends the data wirelessly to a client device for analysis.

A proof of concept prototype was developed to process the signals from bend sensors fitted into the fingers of a glove and to transmit the corresponding data in real time. There are five sensors used in each glove, one for each finger. The sensors consist of a coated substrate that changes in electrical conductivity as they are bent. The wrist control unit, developed by WiSAR, was designed to gather the sensor data and to stream the readings every 25 milliseconds. Firmware for the client device was developed to receive the sensor data and display it on a computer using a serial terminal program. In the first iteration of the firmware an off the shelf USB-BLE dongle was utilised as the client device, a second iteration enabled streaming directly to a mobile phone or any Bluetooth Low Energy (BLE) client. The first prototype was delivered to the client for testing.

A further development of the initial prototype was done with the objective to reduce the overall dimensions of the control unit PCB and to enable production at a contract manufacturer. A 50% size reduction was achieved by replacing some of the main components on the first prototype with smaller footprint components and by utilising a multilayer PCB. The PCB board was designed to hold all components, excluding the bend sensors, and a batch professionally manufactured. Finally, a 3D printed case was designed and printed by WiSAR to house the prototypes. The housing contains slots for the switch, USB socket, bend sensor plug and LEDs.

The outcome from the work carried out by WiSAR was the deployment of working prototypes which enabled ActionSense to perform field trials and gather real time measurements from arthritis patients.

# INSIGHT – NUI GALWAY

## Profile

NUI Galway leading world-class research in data analytics, artificial intelligence (AI) and data engineering. It is host to the Insight SFI Research Centre for Data Analytics, the national research centre funded by Science Foundation Ireland for Data Science.
Insight supports 450+ researchers across areas such as the Fundamentals of Data Science, Sensing and Actuation, Scaling Algorithms, Model Building, Multi Modal Analysis, Data Engineering and Governance, Decision Making and Trustworthy AI. Their research can be applied across four broad areas:

- Health and Human Performance
- Enterprise and Services
- Smart Communities and IoT
- Sustainability and Operations

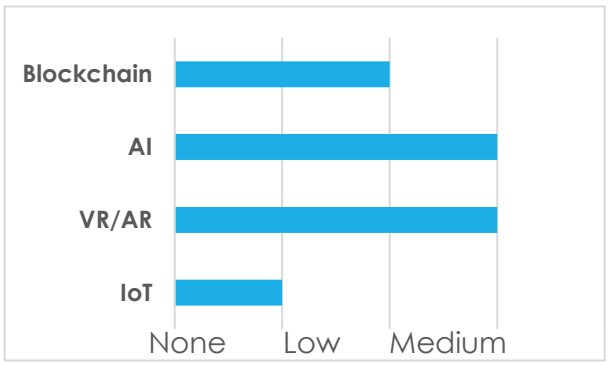
## Contact

**COUNTRY: Ireland**

**REGION: North West**

**WEBSITE:** www.insight-centre.org

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☒ Environmental management

☒ Training

☐ Other:

## EXAMPLES OF APPLICATION

- AI conversational chatbots – Environmental management
- Virtual reality classroom - Training

## AI CONVERSATIONAL CHATBOTS – ENVIRONMENTAL MANAGEMENT

- **Zero waste circular management service**

A service to change public behaviour towards achieving a zero-waste circular district. The service particularly will: 1) Improve accessibility to sustainability information for members of the public and businesses, including those in peripheral areas; 2) Improve communications on Waste and Recycling services through digital offerings; and 3) Better deliver the service to the public with reduced staff overheads (reduced number of calls into agents).

This service uses chatbot technologies providing an online response service on information regarding waste, bin collecting, recycling services, etc. 24 hours a day 7 days a week. It is also aimed at helping people report issues more easily and freeing council staff from dealing with mundane enquiries concentrating instead on more complex questions.

- **Green growth advisory services**

A service to assist advisors in their task of providing advice to the community to be more energy efficient and solve the issue they have to reach a wider audience.

In particular, the new service will use chatbot technologies to: 1) Improve communications on energy and climate with businesses and the general public; and 2) Improve the public awareness of the available services, grants and overall efficiency of different energy options. Currently, this service is delivered via phone calls and face to face meetings with part-time advisers and thus limiting its availability.

## VIRTUAL REALITY CLASROOM - TRAINING

Insight hosted the first Irish virtual reality classroom. Using Altspace VR by Microsoft and using Oculus headsets by Facebook Engineering, they connected students with Insight researcher.

The session involves a researcher from Insight presenting their topic to students in an understandable way in a virtual classroom. This is followed by Q&A which is again followed by a museum tour, research posters on climate exploration, Data Muses, space exploration of data and original pieces of art made by researchers and finally another presentation on data and music.

# ATHLONE IT – COMAND

## Profile

Athlone IT, through the COMAND Technology Gateway concentrates on the research and development of prospective interactive media technologies focused on: cross-platform applications, mobile media cloud, 3D sensing, and the interoperability for the Internet of Things. These technologies are complementary and combine to create the opportunity for new and innovative forms of "connected media" – personalised, real-time, interactive applications – in a wide range of commercial fields including telecoms, gaming, TV, e-health, e-learning, e-tourism, e-retailing, entertainment and digital marketing.

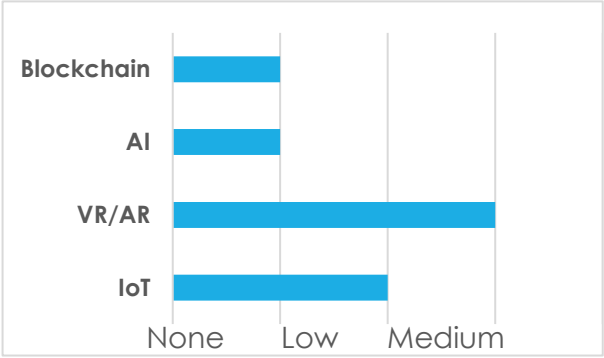
## Contact

**COUNTRY: Ireland**

**REGION: North West**

**WEBSITE:** https://comand.ie/

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☒ Environmental management
- ☒ Training
- ☐ Other:

## EXAMPLES OF APPLICATION

- Smart carers – Health and social care

# SMART CARERS - HEALTH AND SOCIAL CARE

**The challenges**

*1) Stay safe:* Safety at home for live-alone parents, as families can see unusual events such as no morning time activity, no meals prepared, low mobility levels, pill compliance and away from home, after hours.

*2) Stay Connected*: Connect families with parents and each other so they can understand weekly routines, share the care and call to catch-up, not to check-up. Stay Independent: Families provide support to parents to maintain essential skills by understanding when and where support is required, by getting automatic reassurance about medication and food, by allowing them to spot mobility reductions and to help prevent social isolation.

**The solution**

Smartcarers is a smart home product targeted at the elderly care. They use Internet of Things hardware from Samsung and have developed software to allow families or professional carers to remotely monitor elderly people in their homes. Smartcarers benefit the family, the senior as well as professional carers

COMAND developed a new product/service offering using IoT technology. The end product allows real time monitoring of the daily activities of elderly people by either professional carers or their direct family members. The family decides which activities would reassure them that all is okay. Small sensors are placed on household objects and in rooms around the home and the Smartcarers App reassures everyone that all is normal.

# NORTHERN IRELAND

# ULSTER UNIVERSITY (CONNECTED HEALTH INNOVATION CENTRE - CHIC)

## Profile

The Northern Ireland Connected Health Innovation Centre (CHIC) addresses the needs of industry to answer research questions, work collaboratively with other businesses and health stakeholders, and develop skills and knowledge at the leading edge of technology.

CHIC is industry-led, providing an interdisciplinary team of scientists and engineers to deliver collaborative research solutions through an extensive array of capabilities including rapid prototyping, platforms and systems development, artificial intelligence (AI), 3d printing, app development and Internet of Things (IoT) technologies.

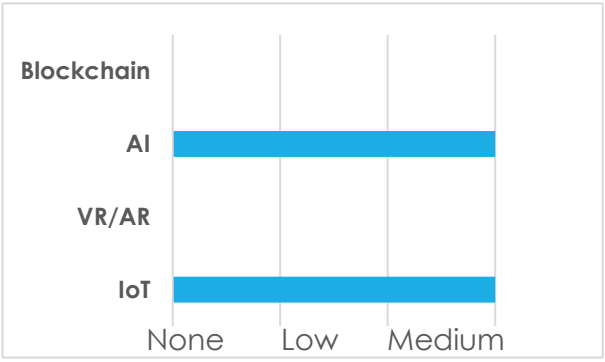
## Contact

**Country:** United Kingdom

**Region:** Northern Ireland

**Website:** www.ni-chic.org

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☐ Environmental management

☐ Training

☐ Other:

## EXAMPLES OF APPLICATION

- Wireless data acquisition from assistive devices to determine efficacy - Health and social care
- Using Artificial Intelligence to detect early signs of Diabetic Foot Disease – Health and social care

# WIRELESS DATA ACQUISITION FROM ASSISTIVE DEVICES TO DETERMINE EFFICACY - HEALTH AND CARE

**CHALLENGE**

To gather data within a paediatric population that can be used to provide evidence for clinical practice. Currently there is little scientific evidence on the benefits of assistive technologies, potentially due to the difficulty in measuring such benefits outside of the clinic.

Issues such as device abandonment and associated costs as well as overinflated perception of high-quality expert care by the patient and family can not be adequately addressed without this data.

It is essential to know if the interventions are working, to prevent device abandonment, false hopes, and unnecessary effort.

**THE SOLUTION**

This project applies state of the art sensor technology, integrated within mobility and postural assistive devices to understand how data gathered within a paediatric population can be used to provide evidence for clinical practice.

The system has been developed to collect movement and kinematic data longitudinally both at home and within clinical settings. The use of sensors to measure motion, potential for feedback to the user, parent or the health professional. The project explored the types of possible data and the potential impact of capturing quantifiable data on healthcare outcomes.

**IMPACT**

As assistive devices (such as wheelchairs, walking frames, and communication devices) form a large part of standard care for children with CP, a systematic, objective and disciplined approach to measuring clinical outcome is needed when prescribing them.

Opportunities exist to utilise longitudinal data to improve the intervention and to provide better engagement with the user through gamification.

# USING ARTIFICIAL INTELLIGENCE TO DETECT EARLY SIGNS OF DIABETIC FOOT DISEASE – HEALTH AND SOCIAL CARE

**CHALLENGE**

It has been estimated, on a global scale, that a limb is lost every 20 seconds due to diabetes. Early detection and treatment have been shown to reduce the risk of amputations and foot ulcers.

Many solutions have been presented for identification of early signs of diabetic foot disease (DFD). In particular the use of thermal imaging has shown promise within the scientific and clinical literature.

However, there is still much research work to be done to create a commercially viable solution for capturing and processing thermal images for the purpose of identifying diabetic foot disease.

**SOLUTION**

This project was focused on using thermal imaging to detect areas of the foot sole that have an increased temperature and are likely to become ulcerated. The system uses an android application and a FLIR ONE thermal camera to capture images and temperature data.

The data is transmitted to a web service where supervised machine learning, registration processes, and temperature comparison are used to evaluate the data and determine whether a temperature hotspot is present. Deep learning approaches are used to detect and segment each distinct foot within an RGB image.

# ULSTER UNIVERSITY (ARTIFICIAL INTELLIGENCE RESEARCH CENTRE - AIRC)

## Profile

The Artificial Intelligence Research Centre -AIRC of the Ulster University aims to develop cutting-edge AI theories, algorithms and tools, and to create state of the art AI solutions for practical problems through engagement with stakeholders and users, and alignment with University, local, national and European initiatives.

AIRC operates across a number of key research areas including: Foundations of Artificial Intelligence, Machine Learning, Knowledge Engineering and Data Analytics and Systems

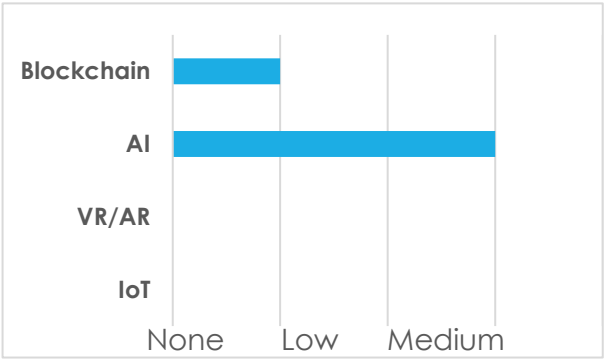
## Contact

**Country:** United Kingdom

**Region:** Northern Ireland

**Website:**
www.ulster.ac.uk/research/topic/computer-science/artificial-intelligence

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☐ Environmental management

☐ Training

☐ Other:

## EXAMPLES OF APPLICATION

- Decision support and Information Management System for breast cancer (DESIREE) - Health and social care
- Virus identification via portable infrared spectroscopy – Health and social care

# DESIREE - HEALTH AND CARE

**BACKGROUND**

Breast cancer is the most common and most deadly type of cancer affecting woman in the EU countries, with more than 460,000 new cases and 130,000 deaths in 2012 (EUCAN2).

Multidisciplinary Breast Units (BUs) were introduced in order to deal efficiently with breast cancer cases, setting guideline-based quality procedures, clinical decisions on cases based on consensus and a high standard of care. However, daily clinical practice and case presentation in the BUs is hampered by the complexity of the disease, the ever-growing amount of patient and disease data available in the digital era, the difficulty in coordination, the pressure exerted by the system and the difficulty in deciding on cases that guidelines do not reflect.

**THE SOLUTION**

DESIREE will provide decision support on the available therapy options by incorporating experience from previous cases and outcomes, and thus, going beyond the limitations of existing guideline-based decision support systems (DSS). The DSS will be based on a knowledge model that will evolve with experience. Patients' cases will be represented using a novel complex Digital Breast Cancer Patient (DBCP) model, which incorporates information about the patient clinical history and diagnostic and therapeutic procedures in cycles that may last for years.

The creation of a DBCP-based advanced knowledge model that incorporates clinical guidelines, clinical experience and important patient context information will provide timely advice on decisions and will reduce the number of decisions that the system is not able to reflect. It will also provide the ability to learn from experience and to evaluate the success or failure of previous decisions. It will exploit the information available both from the current case and from previous similar cases obtained by comparison using the DBCP model. .

**IMPACT**

The DESIREE working prototype has been validated extensively in the four clinical partners of the project. More than 150 patient cases have been analysed and more than 240 decisions have been made. The validation included assessment of usability, medical relevance, perceived usefulness and benefits, and quality of care improvements as well.

# VIRUS IDENTIFICATION VIA PORTABLE INFRARED SPECTROSCOPY – HEALTH AND SOCIAL CARE

Spectroscopic techniques such as infra-red, Raman, and mass spectrometry have long been used to identify chemical compounds and biological species, including bacteria and viruses, usually in specialised lab conditions with high performance instrumentation.

Virus identification in realistic clinical/field environments, using low cost instrumentation, is appealing as it can be widely deployed and so is very suitable for diagnosis, prevention and management in pandemics such as COVID-19. However, low cost instrumentation produces poorly-resolved spectra with added noise.

In this project we will study virus spectral characteristics and investigate how to analyse low quality spectral data. We will then build spectral data-based virus detection models. We aim to develop a spectrometer-fronted, cloud-based system for in-situ virus detection.

The system can record spectra from patient samples and return a positive/negative diagnosis quickly, based on detection models running on a cloud-based service. The system will be validated in realistic environments in collaboration with Northern Ireland Regional Virology Lab.

# NORWAY

# UNIVERSITY OF TROMSØ (UiT)

## Profile

Conducts research in IoT, VR/AR and AI. Facilitates several testbeds and labs in these areas. Among them are: 1. Artificial Intelligence, 2. Computational Analytics and Intelligence (CAI), 3. Health informatics and -technology (HIT), 4. Open Distributed Systems, and 5. Serious Gaming. UiT conducts research regarding technological solutions that promote broad and inclusive social development and a diverse business development in the north. This includes research on technology that solves challenges related to health, the external environment and safety and operations in Arctic regions. Several projects within this research strand cover research on disruptive technologies.

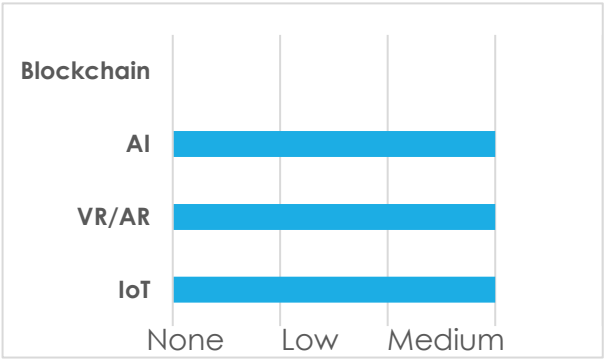
## Contact

**COUNTRY: Norway**

**REGION: Troms**

**WEBSITE: https://uit.no/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☒ Environmental management
- ☒ Training
- ☒ Other: Maritime

## EXAMPLES OF APPLICATION

- Virtual Stain – Health and social care

## VIRTUAL STAIN – HEALTH AND SOCIAL CARE

VirtualStain will develop artificial intelligence (AI) tools to process, label and analyse microscopy and nanoscopy images of tissues and cells. This will make the time-consuming task of chemically staining (with noxious chemicals) such images obsolete. Applying AI to such a task will also enable researcher to image and label living tissues and cells and follow them in real-time. New insights provided on tissue and cell function through these enhanced labelling and monitoring processes will allow for the development of complex and dynamic AI models of tissue and cells systems for use in medical research.

## AUTONOMOUS SHIP PROGRAM – TRAINING

The main objective in this research project is to develop the digital helmsman, ie cloned human navigator behaviour, as a part of ship intelligence to operate future vessels. That will be done by analysing real-world shipping navigation data sets collected by the UiT autonomous test vessel. The data analysis process consists of developing a deep learning based neural network to mimic human ship navigator behaviour in a test vessel, supported by an onshore remote operational center. Furthermore, the cognitive ability of such neural networks under various information sources and visualization methods including human, AI, technology and regulation interactions will also be investigated to support this project

# SCOTLAND

# EDIFY

## Profile

**edify** combines VR with immersive technologies and video conferencing to allow educators to share the power of virtual reality teaching and training - remotely - to learners and trainee's via broadcasting over communication clients such as Microsoft Teams and Zoom.

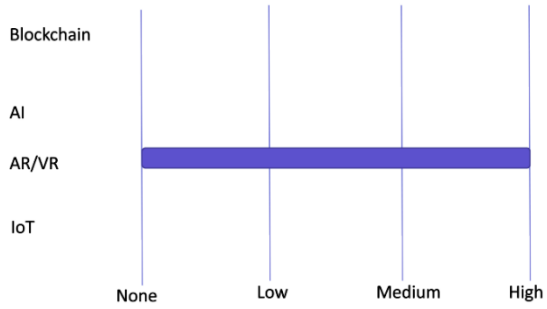
## Contact

**COUNTRY: Scotland**

**REGION: Glasgow office and working across Scotland**

**WEBSITE:** https://www.edify.ac/

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☐ Health and social care

☐ Environmental management

☒ Skills training

☐ Other: Education, Built Environment and Culture and Heritage

## EXAMPLES OF APPLICATION

- Education Beyond Limits
- Win-a-Lab
- Culture and Heritage - Burns Beyond Reality
- Sciences

# Education Beyond Limits

**Edify** is a platform that uses virtual reality and video conferencing to enable accessible, immersive and engaging educational experiences.

Educators can demonstrate concepts in virtual laboratories, environments and worlds while students interact and observe. Over time, the library of experiences will grow to cover all disciplines, and allow for even richer, more collaborative digital learning experience.

Deliver practical demonstrations remotely, for hands-on teaching.

Teach complex subjects more effectively.

Improve the in-person learning experience.

Share your subject on browser, mobile & VR.

## Impossible possibilities.

Go beyond the lecture theatre to explore virtual worlds, conduct challenging or costly experiments and bend the rules of reality manipulating gravity in virtual physics labs.

## Built on brilliance.

Lessons authored by academics for academics, created and built by gamers, technologists and philosophers to augment and optimise learning.

## Tomorrow, today.

Emerging technologies integrated into today's tools, from anywhere, on any device. Spatial computing, AR and VR combined with Microsoft Teams and Zoom to level up learning.

## Open development.

Learning never ends so **edify** is an ever-evolving platform, allowing for the constant creation and discovery of infinite possibilities.

## Personalised progress.

Student performance made visible with data-driven insights and automated reporting to improve the individual.

## Ctrl+Alt+Repeat

**edify** refreshes education to help students learn by doing; to observe, collaborate and practice in their own time. Again and again.

## Early Adopters

Edify held a global competition for academics to fund the development of a VR laboratory. 20 winners were selected with half coming from medicine and life sciences and other labs focused on geoscience, physics, culture and heritage and the arts.

The project was to demonstrate the potential benefits of virtual reality and remote access to state- of-the-art facilities that would be too expensive to physically build or impossible to create in the real world

# Burns Beyond Reality

Ever thought how marvelous it would be to drop into one of Robert Burns' poems to see part of the story unfold?

Or get a live lesson from the comfort of your armchair on one of Burns' iconic poems from a leading expert on Scotland's national bard?

Or how about travelling back in time to Alloway Kirk in the 18th century on a strange haunted night similar to the one encountered by Burns' popular character, Tam o' Shanter?

Now thanks to new virtual reality (VR) education platform edify developed through a partnership between the University of Glasgow and Sublime you will soon be able to do just that.

Dr Pauline Mackay from the University of Glasgow's Centre for Robert Burns Studies has worked with edify VR experts to create a virtual lesson on Scotland's national bard.

Dr Mackay is now able to teach live lessons about the material culture that has been generated by Burns' fame - and specifically by his supernatural epic Tam o' Shanter - to an international audience from her virtual classroom at Alloway Auld Kirk in Ayrshire, Scotland.

## Medicine and Lifesciences

Early adopter projects for Medicine and Lifesciences.

Neuroanatomy - 3D Structures of Human Nervous System

Bi-molecular Interactions in Biochemistry

Lung pathology - Acute Respiratory Distress Syndrome

A Deep Dive into the Depths of the Respiratory System

Stem Cell Experimental Lab

Developing Clinical Reasoning

Into the Matrix – How Our Brains Learn

Learning Equine Techniques using VR

Tracking Through the Spinal Cord

Simulated Bioscience Lab

# SWEDEN

# UMEA UNIVERSITY
# (UMeHealth)

## Profile

Umea University consists of several Labs within the area of AI, IoT, VR/AR and other disruptive technologies. UMeHealth Lab is a regional competence centre for research, education and collaboration on intelligent, person-tailored eHealth interventions, behaviour change systems and decision support. UMeHealth strives to be a cross-disciplinary meeting point that transcends knowledge domains and engages citizens in developing their future digital tools for improving health and wellbeing.

UMeHealth conducts research on decision support, behavior change technology and digital interventions that are personalized, preventive, predictive, knowledge and evidence-based, and developed through participatory design methodologies.

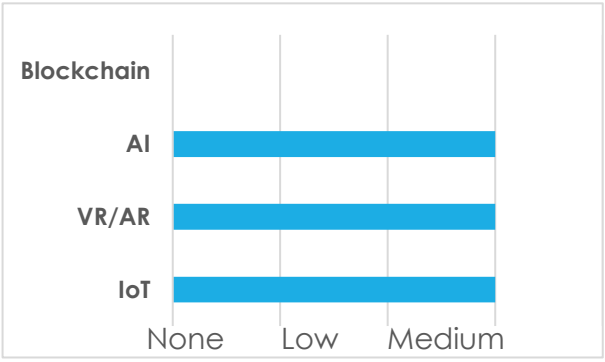
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE:**
**https://www.umu.se/en/research/infrastructure/umehealth/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☐ Environmental management
- ☐ Training
- ☐ Other

## EXAMPLES OF APPLICATION

- The Safe step application – Health and social care

# THE SAFE STEP APPLICATION – HEALTH AND SOCIAL CARE

The purpose of this project is to enhance the knowledge base needed for implementation of health promotion and preventive interventions for older adults. By specifically studying fall prevention, in the format of an M-health (mobile health) intervention, I will evaluate effectiveness, cost-effectiveness, and to what extent the M-health intervention "Safe step" reached the intended population.

# UMEA UNIVERSITY
# (UMIT)

## Profile

Umea University consists of several Labs within the area of AI, IoT, VR/AR and other disruptive technologies. UMIT Research Lab, has as one of their focus Digital Physics which is the art and science of creating virtual environments that evolve according to physical laws of motion. This enables safe and controlled experiments with machines and solutions not yet created. Simulation is essential for developing AI-based perception and control that requiring large sets of (synthetic) training data

The research group is devoted to the underlying computational science - how to achieve rich, faithful & fast digital physics. We also explore new ways of using digital physics that goes beyond traditional use of simulation, e.g., for developing machine perception and intelligence for systems operating in dynamic and unstructured environments

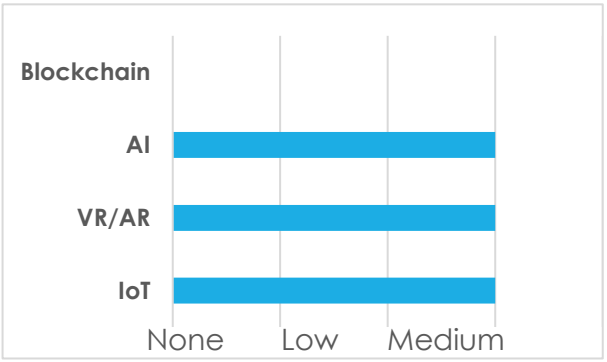
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE: https://www.umu.se/en/research/groups/interactive-and-intelligent-systems/collaborative-ai-lab/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☐ Health and social care
- ☒ Environmental management
- ☒ Training
- ☒ Other: Construction, Forestry and mining.

## EXAMPLES OF APPLICATION

- The Internet of Particles – Mining

# THE INTERNET OF PARTICLES – MINING

The project research computational methods for handling granular material in digital twins of transportation and processing systems. A particular focus is on enabling development of machine learning models for state determination, tracking and prediction where no real sensors can measure. The results will contribute to a virtual testbed of solutions for fully automated mining operations, to be used both for engineering and academic research.

A digital twin is a virtual replica of a real cyberphysical system, like manufacturing or processing plant, or a vehicle. It is based on a large collection of physics-based and geometric models in conjunction with controllers and sensor data in an IoT infrastructure. The digital twin functions as an interface to the real system, making it more easily accessible for monitoring, analysis, machine learning and, ultimately, creating software applications for smart control, predictive maintenance and early detection of risk for catastrophic failure. The major benefit of digital twins is the possibility of experimentation using full-system simulation to investigate radical changes in control strategies and system design. Physics based simulation enables also determination of the internal state in processes and measurement of quantities that are hidden in the real system for practical or fundamental reasons

# UMEA UNIVERSITY
## (Intelligent Robotics Lab)

## Profile

Umea University consists of several Labs within the area of AI, IoT, VR/AR and other disruptive technologies. The Intelligent Robotics Lab figures out how robots can be designed to interact in the best way with humans, other robots, and the environment.

The research contributions in these projects are in the areas of sensory-motor learning, Learning From Demonstration, behavior/intent recognition. A recent field of activity concerns Understandability in robotics, i.e. how robots should communicate the contents of their artificial minds to interacting humans. In this work we combine natural language understanding, dialogue management, intention recognition, and task planning

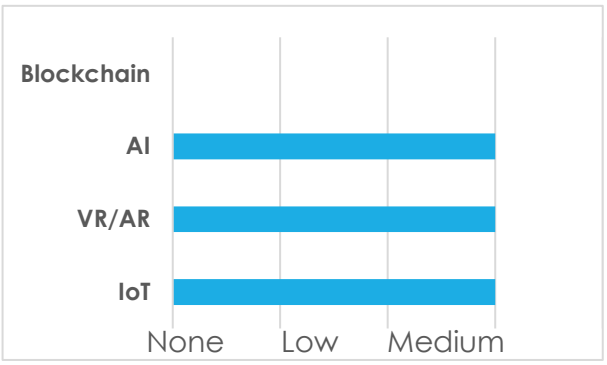
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE:**
**https://www.umu.se/en/research/groups/intelligent-robotics/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☐ Environmental management

☐ Training

☒ Other: Forestry, agriculture especially within harvesting fruits and vegetable crops

## EXAMPLES OF APPLICATION

- CROPS – environmental management

# CROPS – ENVIRONMENTAL MANAGEMENT

Several technological demonstrators have been developed for high value crops like greenhouse vegetables, fruits in orchards, and grapes for premium wines. The CROPS robotic platform is capable of site-specific spraying (targets spray only towards foliage and selective targets) and selective harvesting of fruit (detects the fruit, determines its ripeness, moves towards the fruit, grasps it and softly detaches it).

Another objective of CROPS was to develop techniques for reliable detection and classification of obstacles and other objects to enable successful autonomous navigation and operation in plantations and forests. The agricultural and forestry applications share many research areas, primarily regarding sensing and learning capabilities.

# UMEA UNIVERSITY
# (Collaborative AI Lab)

## Profile

Umea University consists of several Labs within the area of AI, IoT, VR/AR and other disruptive technologies. The Collaborative AI Lab provides the environment for multidisciplinary research collaboration on new theories, methods and technology for human-adapted interaction and human-AI collaboration

Research on human-agent interaction and collaboration includes user modelling, modeling human activity, including its context, environment, and goal models, and methods for detecting intentions. Research also includes methods for collaborating on generating new knowledge, reaching agreements, and deciding what to do, e.g. about a medical condition. Formal dialogue systems as well as other interfaces for human-AI-collaboration are explored.

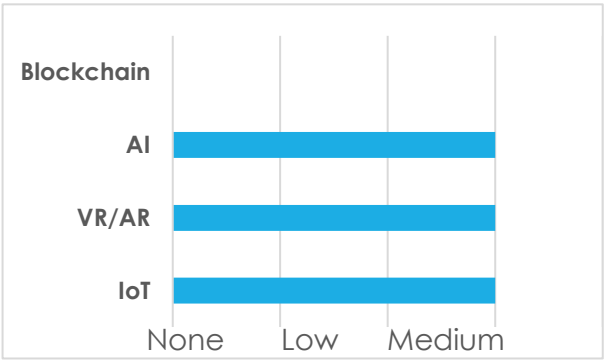
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE:**
**https://www.umu.se/en/research/groups/interactive-and-intelligent-systems/collaborative-ai-lab/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☐ Environmental management
- ☐ Training
- ☐ Other

## EXAMPLES OF APPLICATION

- HumaneAI-Net – Health and social care
- Digital coach – Health and social care

## HUMANEAI-NET – HEALTH AND SOCIAL CARE

The project brings together top European research centres, universities and key industrial champions into a network of centres of excellence that goes beyond a narrow definition of AI and combines world-leading AI competence with key players in related areas such as HCI, cognitive science, social sciences and complexity science.

## DIGITAL COACH – HEALTH AND SOCIAL CARE

Stress-related diseases are increasing in Sweden and is connected to long periods of abscence from work, with high cost for both the individual and the society. To find methods for finding balance in life and facilitate the process back to work is highly important.

The purpose with the project is to develop AI-based person-tailored decision support in the form of a digital coach for managing stress, fatigue, and tiredness, and to provide cognitive support in the process of going back to work when having a stress-related disease. The decision support will use AI-methods for collaborating with the person from the perspective of the individual's goals, needs, motivation and interests in daily life and work. The decision support will be evidence-based and pro-actively coach the person in daily activities that aims at rehabilitation, e.g. physical and cognitive exercise, and balancing rest and activity.

The digital coach will use partly new developed AI-methods based on machine learning and argumentation logics. To give a holistic support to the person, also earlier developed software and AI-methods will be integrated, e.g. a cognitive exercise program that has shown good results on cognitive functions in different patient groups.

# UMEÅ KOMMUN

## Profile

Umeå kommun is a medium sized municipality in the northern part of Sweden. Through one of its companies, Umeå Energi, the municipality has implemented a LoRa-net that covers the whole municipality. This net is open for all services in Umeå kommun to use for applications that suit their business. Companies are also welcome to use the LoRa-net for their applications, but have to pay a fee for their usage.

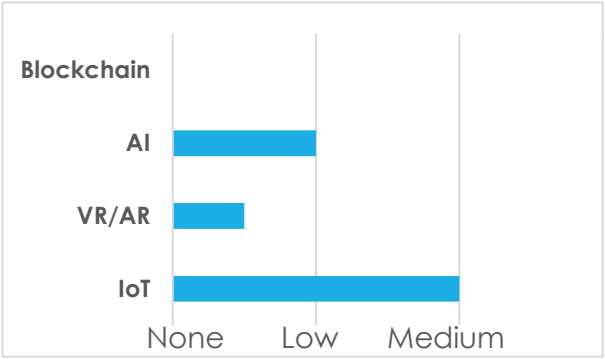
## Contact

**COUNTRY: Sweden**

**REGION: Västerbotten**

**WEBSITE: www.umea.se**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☒ Environmental management

☒ Training

☒ Other: All services that are offered by a municipality

## EXAMPLES OF APPLICATION

- Smart sewer system – Environmental management
- Smart clean out – Cleaning

# SMART SEWER SYSTEM – ENVIRONMENTAL MANAGEMENT

**PROBLEM TO BE SOLVED**

Vakin is a company owned by Umeå municipality that takes care of services such as water delivery, the sewer and waste disposal for the inhabitants of Umeå. This means that they are responsible for both the water mains and the sewer systems. Occasionally pipes break down, and often this result in hours spent to find leak and repair it.

**VAKIN 'S SOLUTION TO THE PROBLEM**

Vakin's solution to this problem is that they have set up a project together with the company Flow Below in which they have placed around 180 sensors measuring leakage in the sewer system in one city district in Umeå. The sensors are wired to the LoRa-net which means that Vakin can monitor data continuously from the sewer system in real-time.

**IMPACT & BENEFITS**

Although the project is on-going it is already clear that Vakin's solution will save both time and money for them. The sensors will assist them in detecting leakage earlier then they would have had without the sensors, and also in finding the leak without having to do a lot of digging.

# SMART CLEAN OUT – CLEANING

**PROBLEM TO BE SOLVED**

Städservice is the unit at Umeå kommun taking care of the clean out of most real estate the municipality owns. Cleaning is done by a schedule that prescribes in which order different rooms should be cleaned, and how often this must occur. One problem with this routine is that quite often rooms that have not been used are cleaned because the schedule says that they should be cleaned.

**STÄDSERVICE'S SOLUTION TO THE PROBLEM**

Städservice are trying to solve the problem with unnecessary cleaning by setting up sensors measuring how often rooms are used. The sensors are wired to the LoRa-net and through their smartphones the cleaning persons can get information on how much a room has been used and when it was last cleaned.

**IMPACT & BENEFITS**

The major benefit of Städservice's solution is that now only the rooms that need to be cleaned are cleaned. As a large number of the municipality's real estate is huge buildings the sensor solution has also meant that the cleaning persons do not have to walk long ways in order to find that the room they was going to clean did not need to be cleaned.

# ORYX AB
(Umea)

## Profile

Oryx Simulations is an experienced, comprehensive partner in building long-term training of heavy-machine operators for cargo, forestry, mining and construction equipment. Their training programmes are based on world-class simulators based on OEM authentic 3D CAD drawings and VR/AR. Oryx Simulations uses these when customising in-service training courses to suit customers' needs and creates comprehend-sive solutions that include e-learning, classroom training, syllabuses and screening as well as guidance and tools for instructors.

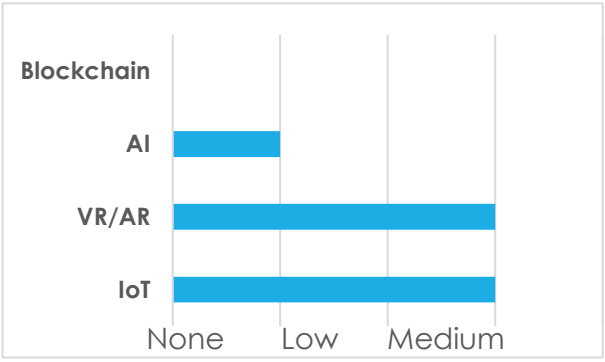
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE: https://www.oryx.se/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☐ Health and social care

☐ Environmental management

☒ Training

☒ Other: heavy-vehicle machines

## EXAMPLES OF APPLICATION

- Virtual prototyping – Construction
- Simulators – Training

## VIRTUAL PROTOTYPING - CONSTRUCTION

By involving simulation early in the development process it is possible to evaluate concepts and purpose built machines on all levels before any hardware is built. Study machine motion and productivity, avoid costly design dead-ends and use the simulation for motivating investments

The real-time physics in our simulation and our sensor simulation layer is accurate and fast enough to handle control systems with high baudrate requirements. The sensor simulation layer is set of signal processing and generator functions written in Javascript easily replacable with your own signal processing code. Our simulation framework has built-in support for a wide range of I/O protocols enabling hardware-in-the-loop development and testing.

## SIMULATORS - TRAINING

Oryx Simulations uses world class simulators when customising in-service training courses to suit your needs and creates comprehensive solutions that include e-learning, classroom training, syllabuses and screening as well as guidance and tools for instructors. Training simulators are used train new operators how to use the machines or experienced operators to increase their skill level. The real-time physics in our simulations sets the stage for having high fidelity machine behaviour which is crucial in simulator based operator training. Our models are based on OEM authentic 3D CAD drawings.

Our Simulator Management System, OPS, is an advanced tool that lets your instructors track operators' progress inside the simulator in detail, making the entire training process more efficient. Instructors can easily create their own training program. A continual stream of detailed statistics and information about their progress is provided.

# REGION VASTERBOTTEN

(Medical Centre for sparsely populated areas)

## Profile

Region Vasterbotten with its university hospital consists of many labs and centers that uses disruptive technologies. One of the centers is Medical Center for sparsely populated areas.

To ensure good health and quality of life in sparsely populated areas, knowledge is needed about the specific challenges, opportunities and needs that may exist in these areas. At the centre, they work with research, development and innovation around good and close care in sparsely populated areas, Sami health, recruitment and education with the aim of increasing knowledge about how health and medical care needs can best be met for the population in Vasterbotten

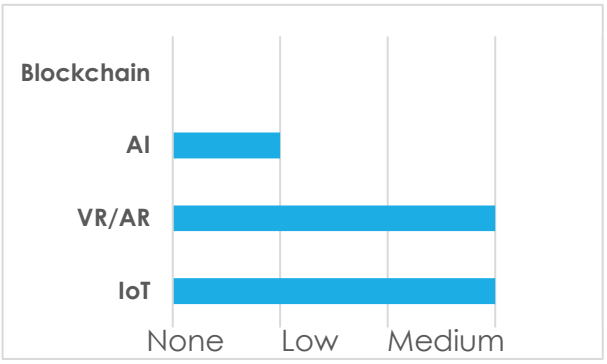
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE:**
**https://www.regionvasterbotten.se/forskning/the-centre-for-rural-medicine-in-storuman**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☐ Environmental management
- ☐ Training
- ☐ Other

## EXAMPLES OF APPLICATION

- Tomorrow's pigeons – Health and social care
- SOS 1.0 – Health and social care

# TOMORROWS PIGEONS DRONES– HEALTH AND CARE

"Tomorrow's carrier pigeons for good and close care - first in the countryside" is a project whose purpose is to enable a change in how transport takes place in health care. More specifically if it is possible to introduce autonomous and electrically powered drones in daily operation to carry samples and medicines.

The background is that caring for sick elderly people in rural areas is a difficult challenge for healthcare. But by connecting virtual health rooms in sparsely populated areas with hospital cabins or hospitals, examination, sampling and medication can be done as if the patient were in the hospital

# SOS 1.0 – HEALTH AND CARE

The overall purpose of the project is to develop knowledge, processes and working methods that can make care and nursing more with the support of simulation and optimization. The goal is a so-called "proof of concept" - we want to show that it is possible to improve complex care chains with these methods.

Expected results: Methods and tools for virtually impact assessment of changes before they are implemented in the business. Methods that make it possible to optimize multi-goal care processes (to simultaneously optimize several different parameters, eg costs and lead times) based on predetermined limitations

# CGI (Umea)

## Profile

Founded in 1976, CGI is among the largest IT and business consulting services firms in the world. Operating across the globe, CGI delivers end-to-end capabilities, from IT and business consulting to systems integration, outsourcing services and intellectual property solutions, helping clients achieve their goals, including becoming customer-centric digital enterprises.

CGI in northern Sweden has been involved in projects that have involved mixed reality, that is, solutions based on both VR and AR.

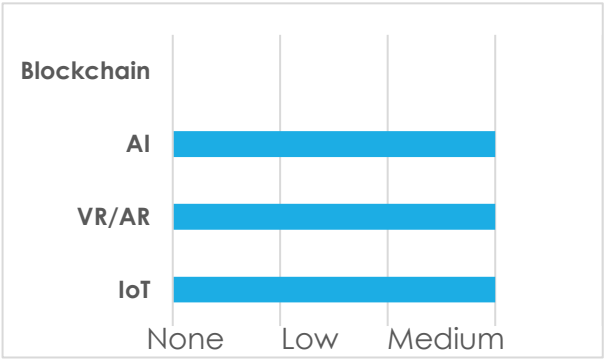
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE: www.cgi.com**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☒ Environmental management
- ☐ Training
- ☐ Other

## EXAMPLES OF APPLICATION

- Hidden city – Environmental management

# HIDDEN CITY – ENVIRONMENTAL MANAGEMENT

For Kiruna, *Hidden City* provides an accurate underground image before starting infrastructure repairs. Too often, installing or repairing underground infrastructure such as pipes or cables happens blindly. When available, maps may be inaccurate or outdated. As a result, what workers uncover at a site often does not match the drawings, causing frustration, time and cost inefficiencies, service interruptions and even traffic delays. There is much to gain from managing underground infrastructure with greater precision.

**How it works**

*Hidden City* uses data on the exact specifications of pipes in conjunction with a precision GPS that relies on satellite systems to keep track of what types of pipes are laid and where. The data is input into the HoloLens and projected onto a grid on the ground. This helps visualize what is underground without actually digging. The technique of adding images to reality through HoloLens makes it possible to visualize, for example, water or power lines underground.

# BRAINSTIMULATION (Umea)

**BRAIN STIMULATION RehAtt**

## Profile

Brain Stimulation AB is a Swedish SME started in 2011 with the aim to provide an efficient assessment and rehabilitation after stroke and traumatic brain injuries. Exploiting brain plasticity results from research within a new concept of rehabilitation and diagnosis of cognitive impairments and disability of attention in stroke patients (Spatial Neglect). We address the global challenge of rehabilitating need for cognitive and upper limb impairments from Stroke, Dementia, Traumatic Brain Injuries, Parkinson and other degenerative brain diseases by using Enriched Rehabilitation.

The products using Mixed Reality will provide task-specific rehabilitation and support E-health- solutions, and on-line support.

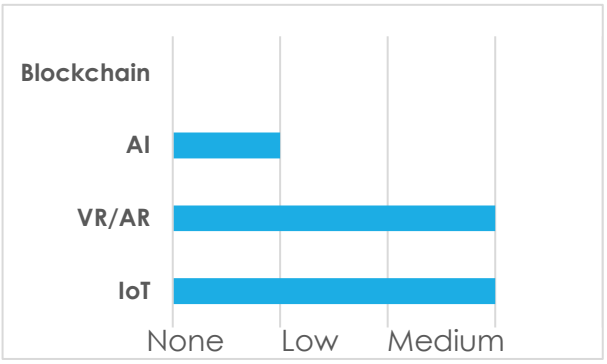
## Contact

**COUNTRY: Sweden**

**REGION: Vasterbotten**

**WEBSITE: http://www.brainstimulation.se/**

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☐ Environmental management
- ☒ Training
- ☐ Other: heavy-vehicle machines

## EXAMPLES OF APPLICATION

- RehAtt® – Health and social care

# RehATT – HEALTH AND CARE

There is a lack of effective treatment for neglect. We have developed a new training method, RehAtt™. The objective of this study was to determine whether RehAtt™ improves spatial attention in chronic neglect after stroke.

RehAtt™ consists of a computer with monitor, 3D glasses, and a force feedback interface (Robotic pen) giving sensory motor activation to the contra-lesional arm. The software combines visual scanning training with multi-sensory stimulation in 3D virtual reality (VR) game environment.

RehAtt™ is a new concept for rehabilitation of neglect. Training with the VR-method improved spatial attention and showed transfer to improved spatial attention in activities of daily living in chronic neglect. Our results are promising and merit further studies

# MID SWEDEN UNIVERSITY – STC

## Profile

STC (Sensible Things that Communicate) Centre at Mid Sweden university, develops sensor-based systems and services for use within Internet of Things and AI. The research is conducted in the electronics and computer science with a focus on Industrial IoT, next-generation measurement systems and functional surfaces.

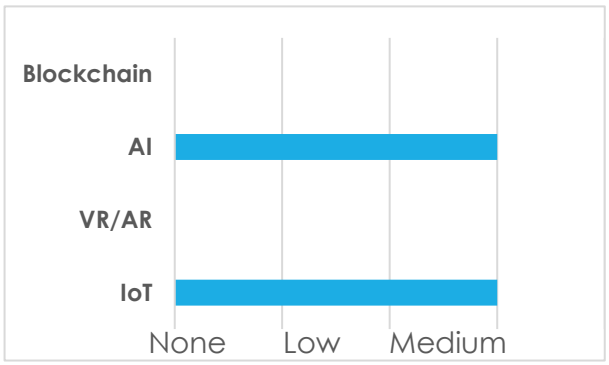
## Contact

**COUNTRY: Sweden**

**REGION: Mid Sweden**

**WEBSITE:**
www.miun.se/en/Research/research-centers/stc/

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

- ☒ Health and social care
- ☒ Environmental management
- ☒ Training
- ☐ Other:

## EXAMPLES OF APPLICATION

- Next generation measurement systems – Environmental management

# NEXT GENERATION MEASUREMENT SYSTEMS – ENVIRONMENTAL MANAGEMENT

- **The challenge**

Climate changes affects the whole world, and as a consequence, the need to measure different environmental parameters increases. For example, by measuring water levels, CO2 levels, temperature and radiation as well as combining these different measurement values in real-time analysis, new opportunities opens to prevent, affect and correct problems in time.

- **The solution**

STC developed a new measurement method that faster can predict the risk of icing on the rotor blades on wind turbines. Using a new camera technique that measures the size of water droplets in fog, the measurement system can predict the risk of icing more quickly. This means that actions can be taken in time to avoid long downtime for de-icing. The result will be a safer and more efficient production of electricity from wind power plants.

# LULEÅ UNIVERSITY OF TECHNOLOGY

## Profile

LTU offers education within the areas of technology, economy, social sciences, language, humanities, music, media, theatre and welfare.

Research is mainly conducted in joint academia-industry projects and within applied technical areas, such as effective innovation and organisation and enabling ICT. Alongside with the development of the basic industries, the economic growth in the northern region of Sweden is highly dependent on SMEs starting new businesses and finding new markets.

The Applied Artificial Intelligence Innovation Hub contributes to improve the quality of productivity, innovation, engineering and every form of activity that AI will influence like everyday life, health, and arts. The Innovation Hub acts as a flagship in AI activities at a national and European level, creating a direct sustainable impact in society.

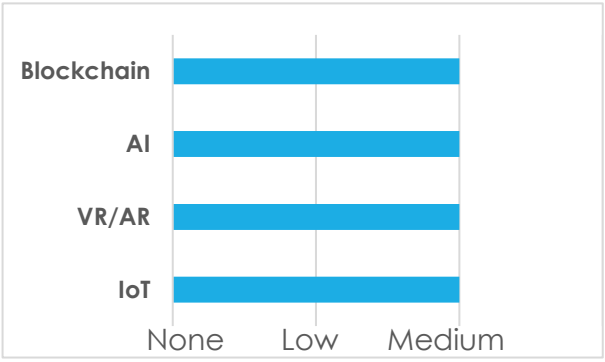
## Contact

**Country:** Sweden

**Region:** Norrbotten

**Website:** www.ltu.se

## DISRUPTIVE TECHNOLOGIES KNOWLEDGE




## SERVICE AREAS OF EXPERTISE

☒ Health and social care

☒ Environmental management

☐ Training

☐ Other:

## EXAMPLES OF APPLICATION

- Mobile games with AI to assist medication – Health and social care
- Digital Platform for trading in biofuels – Environmental management

# MOBILE GAMES WITH AI TO ASSIST MEDICATION - HEALTH AND CARE

**PROBLEM TO BE SOLVED**

The number of people suffering from mental illness has increased in recent years, but the available medical infrastructure does not meet demand. This was one of the reasons why the Skellefteå-based company Mindforce Game Lab began to develop an interactive mobile game that helps people change their behavior and achieve better health. The game, which is registered as a medical device, is aimed primarily at young people suffering from depression and bipolar disorder. The goal is for the user, with the support of a game and a game character, to increase the compliance of their treatment and establish healthy habits around food, sleep and exercise.

**SOLUTION**

Researchers at Luleå University of Technology will, together with the company Mindforce Game Lab, look at the extent to which machine learning can help identify a person's mood and inspire them to take better care of themselves. By developing interactive AI solutions, they hope to help people suffering from mental illness take their medication and keep track of their progress.

The game, called "Fig, a 'playtient' journey", uses a so-called "Tamagotchi effect" to create an emotional connection to the main character named "Fig" in the game. The assumption is based on the fact that caring for the character should inspire the user to take better care of himself and that the main character in the game takes medication regularly and encourages the user to do the same. Using Artificial Intelligence, researchers will analyze the user's behavioral patterns and, using machine learning techniques, identify triggers, examine whether the person is improving or deteriorating, and allow the app to respond accordingly

The work takes place within the framework of the project Applied AI DIH North at Luleå University of Technology.

# DIGITAL PLATFORM FOR TRADING IN BIOFUELS – ENVIRONMENTAL MANAGEMENT

**THE CHALLENGE**

In order for Sweden to be able to restructure the energy system and reach the target of zero net emissions by 2045, a significantly increased use of biofuels is necessary. Digitization of the biofuel market can contribute to an increased rate of change, but for digital commerce to be successful, safety aspects must be carefully investigated.

**THE SOLUTION**

To have established a digital platform for trading in solid biofuels that is used by a significant proportion of market participants.

This issue will be investigated by the new project called Secure information flows with a digital platform for trading in biofuels.

The project will also look at whether blockchains can be used to meet users' demands for safety, traceability and integrity in digitalised trade in biofuels in Sweden.

This project is based on an idea for an efficient and transparent biofuel market where trade is digitized with high safety requirements that are handled with the help of digital technologies, says Michael Nilsson, project manager at the Center for Distance Bridging Technology, CDT, at Luleå University of Technology.

A digital platform, developed for trading in pellets and chips, is already available today via Lithuanian Baltpool, which is also a party to the project. By giving Swedish players access to Baltpool's platform during the project, they get a unique opportunity to analyze what security aspects they require in practice for digital commerce to function optimally in their operations.