



In Collaboration with



BEST GOVERNMENT EMERGING TECHNOLOGIES

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INTRODUCTION

The United Arab Emirates has a strong commitment to be a key player in today's globalised, technology-driven world. Accordingly, it is not only focused on its own development but, as a true global player, also on identifying and promoting those initiatives with the potential to contribute to a real change and improvement in global society.

In fact, the United Arab Emirates has joined with the World Economic Forum to establish a six-pillar plan that includes the creation of the first permanent policy unit to study and implement measures regarding the «Fourth Industrial Revolution» – the transformation of business and society brought about by technological advances and by the adoption of Emerging Technologies.

Following this spirit, the «Best Government Emerging Technologies» recognises governments that are experimenting with emerging technologies to provide government services more efficiently, effectively and have proven results showing how they have created greater public value and transformed people's lives.

For this purpose, the Prime Minister's Office has joined

forces with Indra to analyse and identify 29 Emerging Technologies, grouped in 9 categories that include technologies such as Artificial Intelligence, Blockchain, Cloud Computing, Robotics & Space, Smart Platforms, amongst other.

Wherever possible, case studies have been analysed as example of the use of the technology in public bodies and government, taking into account that some of these technologies may not have been implemented yet in the public sector and therefore have not affected the lives of citizens. The analysis comprises 73 international case studies from 32 different countries.

This document represents an executive summary of the analysis findings, incorporating a brief description of the main Emerging Technologies where the selected cutting-edge digital technologies are introduced, followed by a number of examples of international case studies in which governments and public bodies have implemented these technologies.



ABOUT THE AWARD



'The World GovTechioneers Race' is an annual award designed to motivate government entities to promote creative smart government initiatives & partnerships with the aim of providing innovative smart solutions for common global challenges.

Previously focusing on best mobile government service applications, the Award is now in its 4th cycle under an overarching accolade named 'World GovTechioneers Race'.

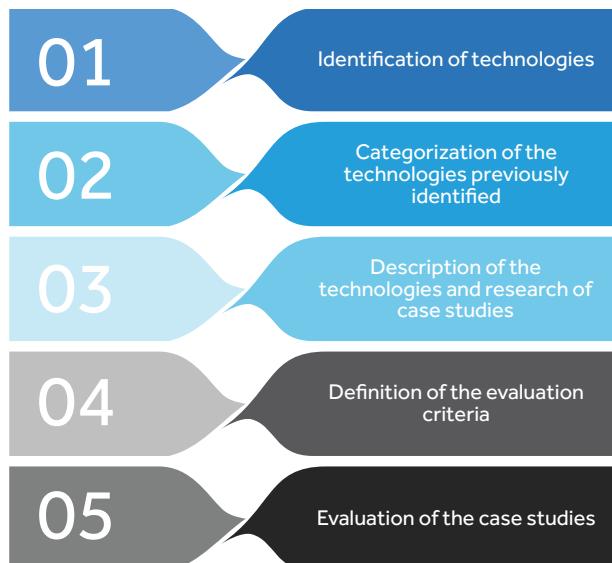
Following the extension of its current scope, the award will now also include a global virtual hackathon 'Blockchain Virtual GovHack' aimed at experimenting with new technologies to produce outstanding applications designed and developed by students and start-ups from across the world under the ethos of hacking for good.

The Race will also feature 'Best Government Emerging Technologies Award', which is an award for governments that are experimenting with emerging technologies to provide government services more efficiently and effectively and that have proven results of how they have created greater public value and transformed the lives of people.



APPROACH

The aim of the analysis is to identify the 'Best Government Emerging Technologies' and it has been structured in the following phases:



01) Identification of technologies

In order to identify the most relevant emerging technologies in the area of digital solutions within government organisations around the world, there has been identified a panel of experts in a variety of digital technology fields (IoT, Big Data, AI, Cloud, Nanotechnology, etc.) and digital solutions (eHealth, Smart Cities, Smart Mobility, eLearning, e-Government, etc.)

The various experts have accumulated their knowledge not only through their vast experience working in numerous IT sectors and international projects, but also from their market research units, knowledge networks and technology partners, participation in innovation forums and clusters at different universities and start-ups.

To ensure the precise and meticulous classification of these technologies, all innovative initiatives currently under way under the auspices of the European Commission have also been taken into consideration, including the Future and Emerging Technology

Flagships, EIT Digital, European Technology Platforms, Knowledge and Innovation Communities and other innovation programmes.

02) Categorization of the technologies previously identified

For a high level reporting, the technologies have been organised into fields or areas, resulting in nine general categories:

- Artificial Intelligence
- Blockchain and Distributed Ledgers
- Citizen Engagement & Analytics
- Cloud and High Performance Computing
- Nanotechnology
- New Manufacturing
- Robotics & Space
- Smart Platforms
- Virtual World

03) Description of the technologies and research of case studies

For each technology there has been developed a description, including their added value, degree of innovation and level of maturity, as well as the impact their case studies could potentially have on society.

Furthermore, wherever possible, international case studies have been included as example of the use of the technology in public bodies and government, taking into account that some of these technologies may not have been implemented yet in the public sector and therefore have not affected the lives of citizens. This may be because they are still in the research or pilot stages.

04) Definition of the evaluation criteria

The case studies are evaluated based on the five evaluation criteria described below:

- Sustainability
- Readiness
- Replicability & Scalability
- Innovation
- Impact

Sustainability is based on three balanced pillars, Social, Economic and Environmental, allowing present development without compromising the ability to meet future needs.

This criterion takes into account the ability to solve citizens' social needs, but should also consider long-term maintainability. Therefore, the digital solution must be economically reasonable and cost effective, and finally, eco-friendly aspects and environmental issues, such as not generating pollution, must be considered.

Readiness assesses the development maturity and availability level of the technological solution, taking

into account the complexity of its implementation and measuring the agility, riskiness and flexibility of its deployment.

Replicability & Scalability mean that public bodies all over the world can adopt the same approach and easily evolve it to meet future challenges.

Innovation measures the level of disruption and novelty of the solution, taking into account two dimensions: first, the resolution of new issues that have never been addressed, and second, the definition of new ways of resolving existing issues in a more efficient way by defining new processes and offering better services.

Impact considers the capacity of the solution to solve public problems. Furthermore, the number of organisations, public bodies and citizens that benefit from the use of the technical solution will also be taken into account.

These criteria are assessed within the spirit of the award. Accordingly, dimensions such as Impact and Innovation are considered to be critical, although the other dimensions are not ignored.



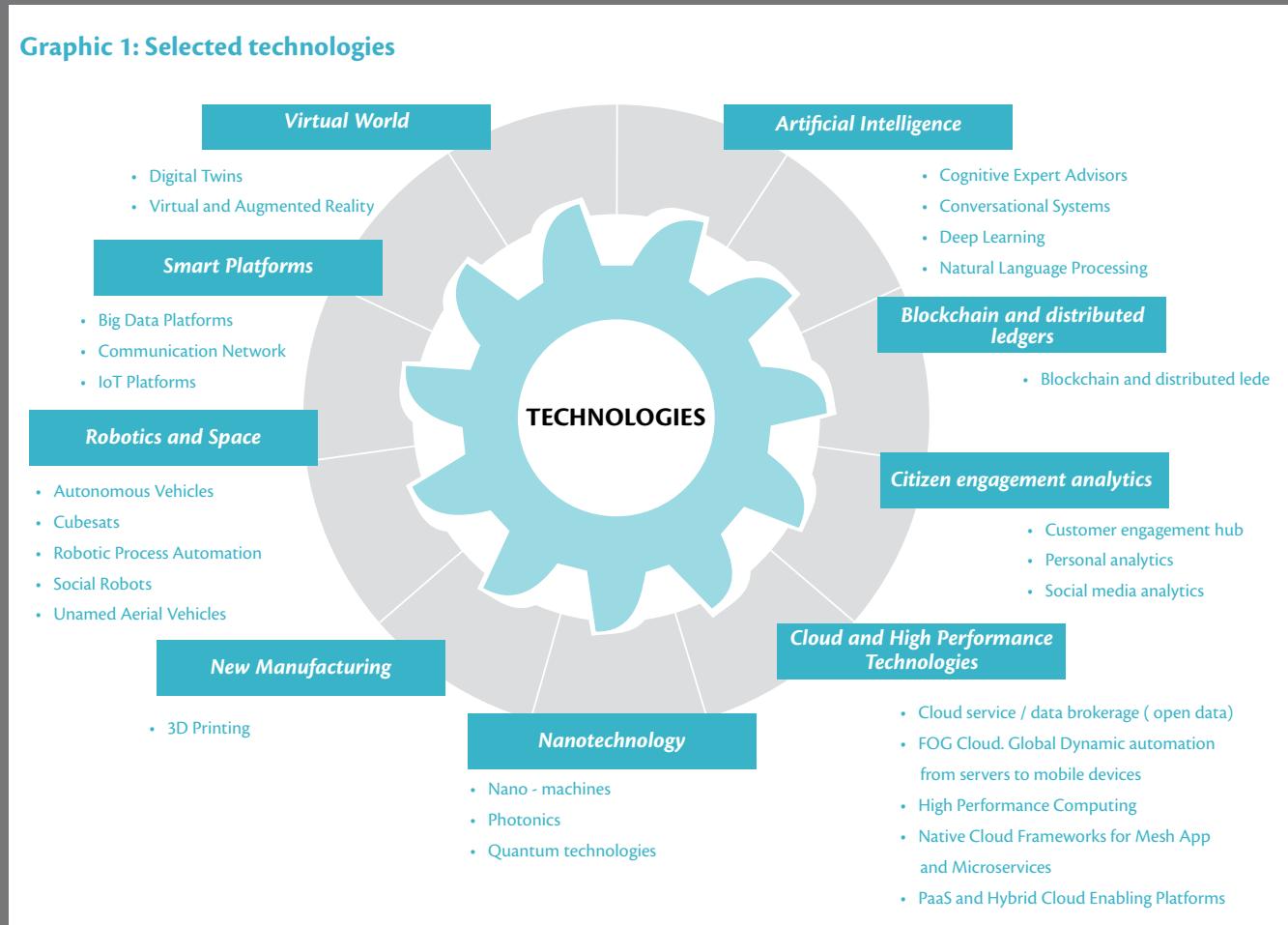
TECHNOLOGY AND CASE STUDIES

The final technologies list (Graphic 1) was made up of the most cutting-edge technologies that can be applied in digital solutions used by public bodies.

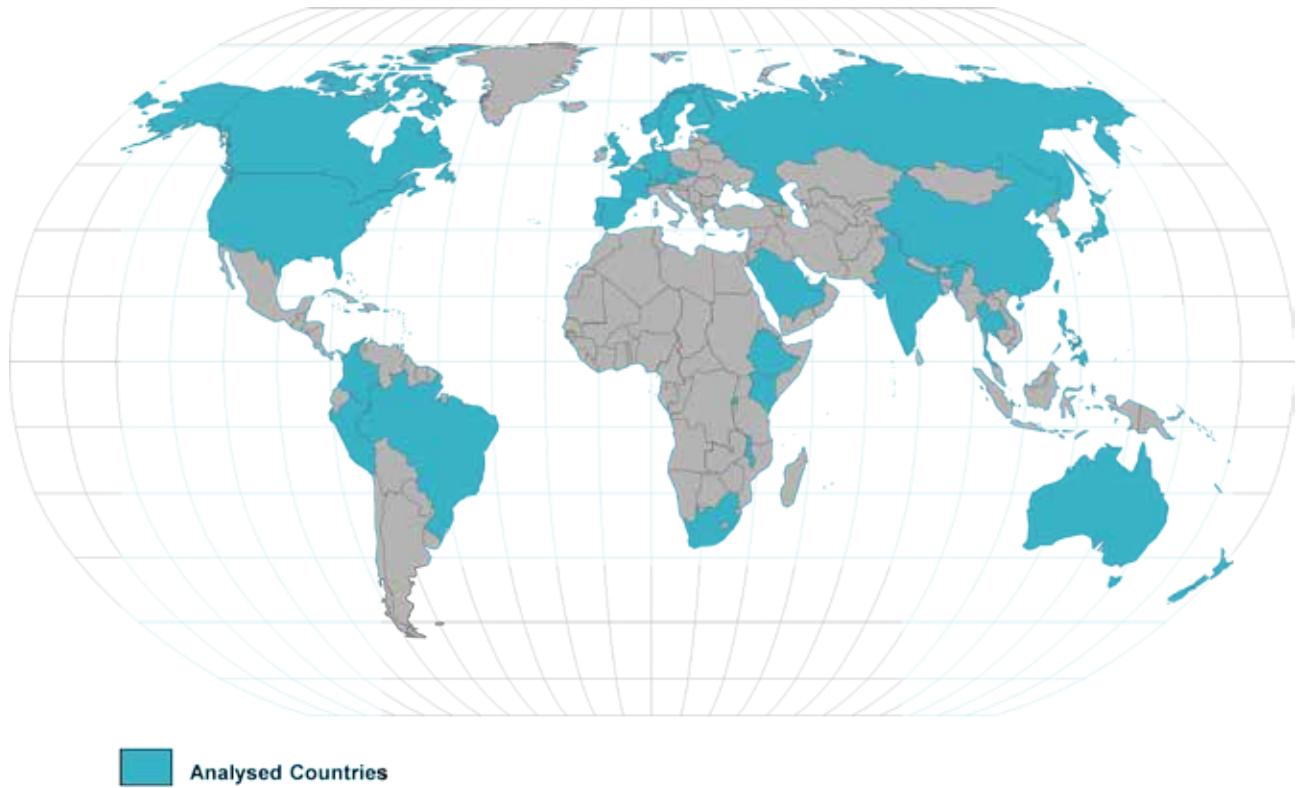
In order to summarize the analysis done, it is included the graphical representation of the countries of the Case Studies that have been analysed (Graphic 2) and the main figures of the analysis (Graphic 3)

In the following pages, it is included an abstract of the analysis done, including a brief description of the main Emerging Technologies where the selected cutting-edge digital technologies are introduced, following by some examples of international case studies in which governments and public bodies have implemented these technologies.

Graphic 1: Selected technologies



Graphic 2: Countries of the Analysed Case Studies



Graphic 3: Analysis Main Figures

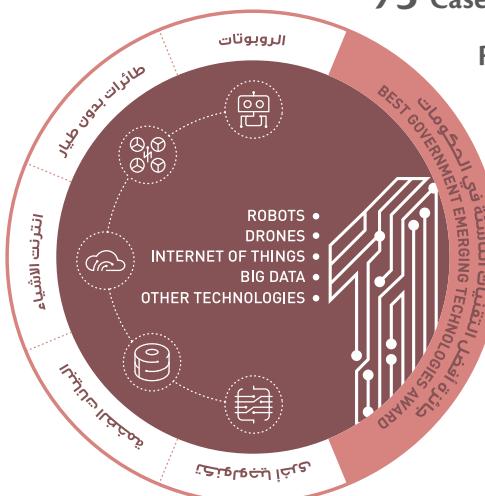
Best Government Emerging Technologies Award

73 Case studies analyzed

From 32 Countries



جائزه أفضل التقنيات الناشئة في الحكومات BEST GOVERNMENT EMERGING TECHNOLOGIES AWARD



Criteria

Impact

Innovation

Readiness

Scalability & Replicability



ARTIFICIAL INTELLIGENCE

"Artificial intelligence is the science of making machines do things that would require intelligence if done by men", Marvin Minsky (mathematician, computer scientist, and pioneer in the field of artificial intelligence).

Smart machines (Machine Learning/Deep Learning, Virtual Personal Assistants, Cognitive Expert Advisors, Smart Data Discovery, Conversational User Interfaces, Natural-Language Question Answering, etc.) will be technological disruptors because of the effects they will have on society and daily life of citizens (personal and professional). In business, the competitive advantages of these emerging technologies are the capability of providing higher profit margins and leading to more efficient manufacturing processes.

Smart machines stands poised to unleash another cycle of raised citizens' expectations, changing behaviors, and disruption: technologies with the potential to redefine how governments serve citizens.

Case Study: Philippines - Department of Science and Technology - Intelligent Operations Center



Summary

Intelligent Operations Center software helps Philippine's Government leaders manage different incidents and emergency situations such as natural disasters delivering operational insights.

The system offers integrated data visualizations in near real-time collaboration and deep analytics to help city agencies to achieve the greatest efficiency of city operations.

It is composed by integrated maps, online dashboards, customizable reports, multiple analytic algorithms, interactive standard operating procedures and other tools for improved city operations and incident or emergency response.

Philippines - DOST Intelligent Operations Center in depth

The Department of Science and Technology (DOST) and IBM have unveiled a new intelligent operations centre to provide a central point of command for disaster management.

The new centre will help the Philippine Government to manage better ongoing and future disasters response and recovery efforts.

Thanks to the Cognitive Expert Advisors Technology, this integrated solution pulls data from disparate

Entity

Department of Science and Technology

Region and location

Philippines



Applicable technologies

- Main: Artificial Intelligence (Cognitive Expert Advisor)
- Others: Cloud and High Performance Technologies (Cloud service / data brokerage open data) and Smart Platforms (Big Data Platforms)

sources into a common view, providing emergency managers with critical information such as advance warning for extreme weather events, feedback from first responders on the number of casualties and affected families, condition of buildings, roads and infrastructure.

These distributed data sources provide analytics and scenario planning to streamline and integrate the government's response to disasters. In addition, the

solution will enable advanced communications for first responders and emergency personnel.

These solutions have a great impact over citizens because they address the government's need for

better decision-making support and provide as well a starting point to better manage future responses.

Video:

<https://www.youtube.com/watch?v=TSsoJ1u1UBw>



Case Study: Singapore Government – Conversational Systems



*“Hi, my name is Jamie.
Click here to ask
me a question”*



ASK JAMIE ON MSF WEBSITE

Summary

The Singapore Government wants to use technology to improve public services. Currently, it is building a prototype chatbot for selected public services, which is an evolution of the previously implemented virtual assistant. The Infocomm Development Authority will use conversational computing to deliver selected public services under a new initiative called «Conversation as a Platform».

This initiative is a disruptive change; an attempt to dominate the next shift in computing: people will be talking more and more with computers, which could result in the biggest shift in computer interaction since the graphical user interface.

Singapore Government – Conversational Systems in depth

The initiative called «Conversation as a Platform» will allow citizens and constituents to interact with their public services digital lives: intelligent services that respond, act and communicate in new ways that can augment human abilities and experiences in a trustworthy manner.

In other words, «Conversation as a Platform» will be the new medium to deliver government services to citizens in a more intuitive way.

Entity

Singapore Government

Region and location

Singapore



Applicable technologies

- Main: Artificial Intelligence (Conversational Systems)
- Others: Artificial Intelligence (Natural Language Processing) and Citizen Engagement & Analytics (Customer Engagement Hub)
-

The next step will be the design and development of conversational computing for Singapore's government website.

The shift to conversational computing with citizens will be implemented in three phases:

- In the first phase, the government will build Chatbots that will answer simple factual questions.
- In the second phase, the Chatbots will help citizens to complete tasks and transactions within government websites.

- And finally, the Chatbots will be customised to each user to serve their needs better.
- Fundamental benefits for citizens:
- Greater convenience and 24/7 accessibility to the government.
- Quick, consistent and direct answers to queries.
- Availability of self-help and reduced need to call Call Centres.

- Ability to get help without knowing which agencies to go to.
- Better user experience through using conversations to get help.

Video:

<https://www.youtube.com/user/IDASingapore>



Case Study: Dutch Government - Using Text Mining and Machine Learning for Detection of Child Abuse



Summary

Unfortunately, child abuse is widespread. According to the World Health Organization estimation in 2001 40 million children were subject to abuse or neglect each year. Moreover, a 2015 UK study concluded that as little as only 1 in 8 victims of sexual abuse may come to the attention of the police and children's services.

Nevertheless, the Netherlands national healthcare organization has used all the unstructured semi-medical data generated from children visits to doctors for predictive analysis to create a decision support system in order to automatically identify abused children.

Dutch Government - Using Text Mining and Machine Learning for Detection of Child Abuse in depth

The automated identification of abused children is a critical issue in nowadays society and well-trained people are in short supply. A recent (2016) German study concluded that everyone working in the area of child protection should receive additional interdisciplinary training, but such training might prove to be costly and time consuming.

However, the automated analysis of relevant child health data is hampered by the fact that a significant part of the medical data that institutions have on children is unstructured and in the form of free text

Entity

GGD (Gemeentelijke Gezondheidsdienst - Netherlands) National Healthcare Organization)

Region and location

The Netherlands



Applicable technologies

- Main: Artificial Intelligence (Natural Language Processing)
- Others: Citizen Engagement & Analytics (Personal Analytics and Social Media Analytics) and Smart Platforms (Big Data Platforms)

notes. Indicators of child abuse, in contrast to obesity, are hard to capture in structured data.

As a result of this research, it was implemented a Decision Support System for child abuse identification, based on knowledge mined mainly from unstructured medical and semi-medical records, using a machine learning approach.

The model is reinforced and continuously improved using feedback from healthcare personnel each time a case is closed in the information system.

The base technology used was open source (based on the Python language and packages).

Specifically, the work carried out in this project was fourfold:

1. A study to determine whether paediatric data contain patterns indicating child abuse.
2. A comparison of machine learning methods for this task.
3. The evaluation of some of these methods by healthcare professionals.
4. An implementation of the prediction model in a Dutch municipality through an API.

It is important to state that there is no precedent of identifying child abuse from semi-medical texts and no previous research has used unstructured semi-medical data for predictive analysis.

For this research, data were provided by the children's health department (JGZ) of the largest public health organisation in the Netherlands, GGD Amsterdam. In addition, the JGZ also provided knowledge and expertise in the form of paediatricians in a scrum group. The data consisted of (partly medical) files on

13,170 children born in 2010 in the Amsterdam region, all reaching the age of four in 2015 (when this research was conducted). With an average of 14.8 contacts with the JGZ per child, these visits resulted in 195,188 individual data entries. 657 of the 13,170 children had been labelled presumably abused by the JGZ over the course of four years. It is important to note that the JGZ estimated that these 657 children account for 25 to %30 of children that should have been labelled.

The performance of the resulting decision support system was not only evaluated mathematically, but also by comparing its classifications with those made by JGZ experts on child abuse. The high degree of agreement between the experts and the ensemble classifier led to wide acceptance of the proposed decision support system among the end users from the Dutch Youth Healthcare Agency (JGZ).

Thanks to the system, a major data capability analysis is achieved with the usual way of working of healthcare and social workers including namely unstructured, natural language notes and reports.

Video:

<https://www.youtube.com/watch?v=m3JPt1W40QI>

<https://vimeo.com/109929521>



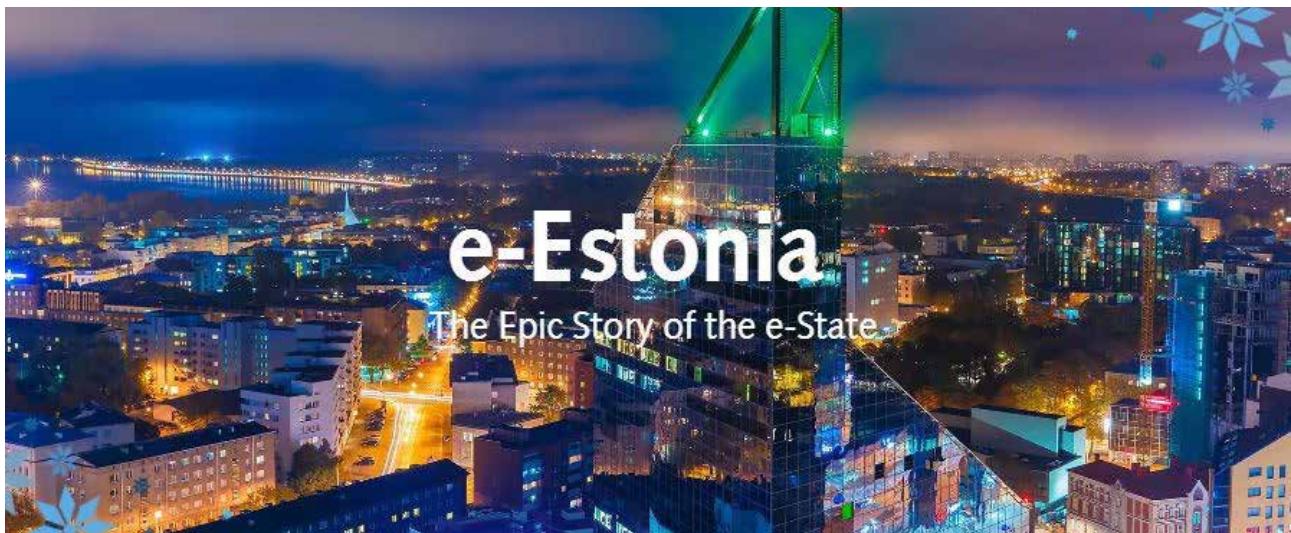
BLOCKCHAIN AND DISTRIBUTED LEDGERS

Since the first appearance of Blockchain in 2009, the interest shown in this new technology has only increased. Silicon Valley, Wall Street, Singapore and Hong Kong have come up with great ideas accompanied by millions of dollars to develop them.

First applications for this global network that is independent of governments and public and private organisations are being made by small start-ups and open-source communities.

Although it is still in pilot phase, experts predict that it will disrupt every industry which is heavily intermediated, especially those industries intermediated by legacy gatekeepers, or those entities which represent a potential conflict of interest between the parties. The most obvious example of the former is international remittance. Regarding the latter, Blockchain will disrupt industries like energy and communications infrastructure. Blockchain will also radically disrupt IoT by enabling scalable architectures for the so-called economy of things.

Case Study: Estonia's Blockchain – based eHealth Record



Summary

Estonia is currently both a leader and a visionary in the scope of e-Government.

A major trend in Estonia's approach to e-Government is the use of blockchain for a wide variety of record management systems. The most mature initiative currently in place is the Estonian e-Health Foundation's deployment of a blockchain-based system to secure over one million patient healthcare records.

Entity

Estonia government and private sector collaboration (Estonian eHealth Foundation)

Region and location

Estonia



Applicable technologies

- Main: Blockchain and Distributed Ledgers (Blockchain and Distributed Ledgers)
- Others: Smart Platforms (Big Data Platforms and Communication Networks)

Estonia's Blockchain – based eHealth Record in depth

Since 1991, all Estonian society (government, private entities and citizens) has been committed to transforming the country into the world's first e-country, inhabited by e-citizens.

Estonia's commitment to IT has been all encompassing. This small Nordic country has achieved some impressive results. For example, it is a pioneer in delivering e-Passports to its citizens and, today, it is the first country in the world to create the concept of e-residents.

IT usage is so pervasive that, as early as 2007, a mass, countrywide cyber attack suspected to have been

orchestrated by Russia provoked the country's near collapse.

Estonia first started to reinterpret the concept of "e-Government" when it decided to undertake a radical overhaul of its main public record systems (healthcare, contracts, marriages...)

The most mature of these initiatives is its Digital Health Infrastructure, which is not just a blockchain initiative, but encompasses a major medical process reengineering effort, including the mass digitisation of medical documents.

The use of blockchain in healthcare poses a number of unique challenges, such as:

- Confidentiality: unlike "classic" blockchain use cases like Bitcoin, health record management requires a high level of confidentiality (especially in European Union Member States, which are subject to Data Protection Directive 95/46/EC), so the "usual" approach, i.e. a public readable ledger, is not feasible. Health-oriented blockchains require facility-level protection (that is, all health records, regardless of the underlying technology, require the proper level of physical custody).
- Cryptographic protection: physical protection precludes the need for the cryptographic signature techniques (such as the discrete elliptic curve approach adopted by Bitcoin) commonly used in blockchains oriented to the recording of transactions.
- Availability and resilience: healthcare record management requires total fidelity and accuracy, guaranteed accessibility and resilience to disruptive events. All threats to these requirements must be addressed from the very start.

It should be stated that today there are no public key cryptography methods that are resistant to new and active cryptology techniques; in fact it is estimated that it will take about ten years for such methods to

achieve the maturity required for their use. Clearly, infrastructures as important and large-scale as national e-health records must be resistant to such envisioned threats.

The response implemented in Estonia was launched in partnership with the Estonian startup Guardtime, which provides state-of-the-art, proprietary, non-encrypted, hash-based, quantum-resistant blockchain technology.

The Estonian eHealth Foundation uses Oracle technology to process and store its patient records and Guardtime's KSI blockchain is integrated at the Oracle database engine, providing increased security, transparency, auditability and governance for electronic systems and lifecycle management of patient records. KSI instrumented records will be irrefutable.

This technology has indefinite scalability and is capable of detecting unauthorised changes made in the health record blockchain; even if attackers gained access to premises, their changes would be detected. Patients do not have to take the Estonian e-Health Foundation's claims on faith, as they themselves can check the validity of their own records.

Video:

<https://e-estonia.com/the-story/the-story-about-estonia/>



CITIZEN ENGAGEMENT & ANALYTICS

Citizens are living a data explosion, every single action generates data that can be processed. Traditionally IT systems have become obsolete. Therefore innovation around analytics started to come up. Since every set of data can be stored, processed and analysed, organizations are seeking a more efficient way to advance their needs while increasing their business value.

Public sector should be considered as an enabler of digital transformation delivering better services by following its citizen's needs. Social Media Analytics, Customer Engagement Hub and Personal Analytics appears to be the main engines of government's digital transformation.

The challenge is to exploit real-time data continually gathered from people, devices and sensors linking people, cities and governments assuring security and privacy.

Case Study: Denmark Government Healthcare



Summary

The Danish government has been modernizing its healthcare system for many years. Many initiatives have been carried out from a number of large-scale telehealth projects, which have been running until 2015, to the construction of new specialized and highly-computerized hospitals.

The main aim is to set up a more efficient and sustainable Healthcare system that can be accessed by everyone and respond to citizens needs, improving disease prevention, diagnosis and treatment.

Entity

Denmark Government

Region and location

Denmark



Applicable technologies

- Main: Citizen engagement & analytics (Personal Analytics)
- Others: Citizen engagement & analytics (Big Data Platforms and Customer Engagement Hub) and Internet of Things (Communication Networks)

Denmark Government Healthcare in depth

The Danish healthcare system is characterised by its extensive digitisation, electronic communication between healthcare providers and systematic use of data and digitised working procedures in order to improve autonomy and life quality of citizens (especially vulnerable collectives such as chronic patients).

Some of the outstanding projects and pilots using personal analytics technologies to help in its purpose are detailed below:

- Connection of citizens with diabetes, metabolic disorders and calcium disorders: Connection with healthcare officials through virtual endocrinology outpatient clinics; the project is expected to connect as many as 20,000 patient through video consults in the southern part of the country and Zealand.
- Connection of young citizens with type 1 diabetes: Allows the connection with hospital staff and monitorization of relevant data. Already deployed in Copenhagen and Zealand.

- Home rehabilitation and physiotherapy: Already launched in Copenhagen aiming to reduce hospital readmissions.
- Monitoring of patients with chronic obstructive pulmonary disease (COPD): Nationwide project to monitor different relevant data in nearly real-time. Pilots have already been deployed in the northern region.
- Monitoring program for patients with heart issues: Already deployed in the northern region of Jutland.
- New assisted living technology for elderly care: Many initiatives such as nursing home, where nurses can manage a large number of care visits with support from the mobile app, or virtual rehabilitation solutions that use sensors to monitor and register exercises, allowing the citizen to do rehabilitation independently in a guided way.
- Prevention of Acute Admissions by TeleHealth (PAATH): Home monitoring to connect elder residents to healthcare providers, reducing acute admissions. The project will include video consults and the monitoring of blood pressure and pulse rates, among other vital signs for elder citizens in the southern part of the country and Svendborg.
- Self-tracking: A group of patients at the hospital in Vejle (Denmark) is testing how self-tracking can help the healthcare services to tailor a treatment that is more personal, efficient and easier to deal with for the patient.
- Wireless pump for Cancer patients: Thanks to this wire 150 patients already get chemo therapy at their homes.
- Thanks to tracking systems such as tablets which contain information on how to manage with chronic diseases in general and guidelines, patients can be self-monitored. The system also transmits wirelessly disease specific data (blood pressure, pulse, oxygen saturation and weight) using fingertip pulse oximeters, blood pressure monitors and precision health scales. Physicians can monitor patient's health status in real time.

With this digitalized system, citizens have access to their own medical data from national health registers, electronic health records (EHR), medication data, etc. These data can also be accessed by the patient's general practitioner.

E-Journal is designed to extract information from hospital EMR systems from all regions, which will provide healthcare practitioners with an overview of a patient's medical record in relation to a hospital visit.

The success of this system is thanks to the work of all general practitioners that keep electronic health records (EHRs), exchanging 98% of the records electronically and sending 99% of prescriptions electronically to the pharmacies.

Video:

<http://healthcaredenmark.dk/the-case-of-denmark.aspx>





NEW MANUFACTURING

The manufacturing sector is key to the promotion and dissemination of technological change, which in turn is a crucial driver of competitiveness and economic growth. Industrial development therefore has great potential to achieve a number of social objectives, including high rates of employment, poverty eradication, gender equality, labour standards and better access to education and healthcare.

Additive Manufacturing is enabling the cost effective production of highly complex components in relatively low production quantities. This is giving designers unrivalled freedom, unlocking their creativity and fostering a new generation of entrepreneurs able to explore new market opportunities without the high barriers to entry associated with conventional manufacturing.

Case Study: Mayo Clinic - 3D Printing



Summary

For nearly ten years, Rochester's Mayo Clinic has been creating life-like models of people's organs, vascular systems, and bones to help with surgery. This is all done using a 3D printer, which Mayo Clinic says the demand for it is only growing.

3D printing allows the medical team to manufacture a copy of the bone or organ to be operated on. The medical team can practice with a replica, which means that the surgery will take less time, unforeseen situations will be reduced and higher rates of success will be achieved.

Mayo Clinic – 3D printing in depth

The Mayo Clinic in the United States is one of the pioneers of 3D printing in healthcare. Initially, the clinic used the 3D printing technique for prostheses. This was followed by printing bones and now the most common application is in surgery preparation. In addition to trauma surgery, many other types of operation are prepared using this technology, such as tumour extirpations and operations in which the surgery site is difficult to access. Operations that used to be long and have variable results are

Entity

Mayo Clinic

Region and location

USA



Applicable technologies

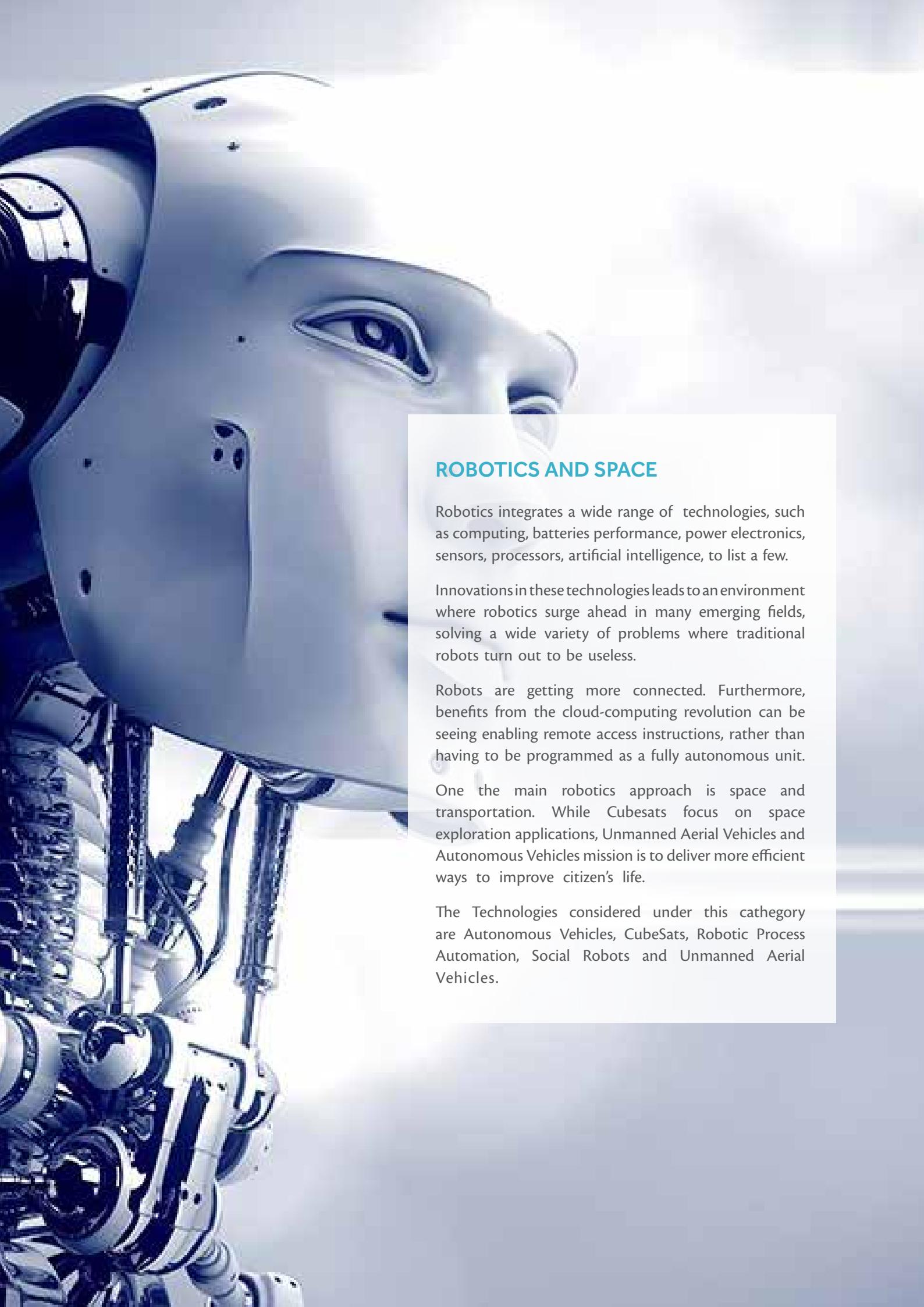
- Main: New Manufacturing (3D Printing)
- Others: Robotics and Space (Robotics Process Automation)

now confidently performed in much less time with much more predictable outcomes. More than 200 radiologists and numerous other professionals work with 3D technology at the Mayo Clinic.

The Mayo Clinic now teaches courses to train a wide variety of professionals to use 3D printing techniques in the sphere of healthcare in the United States.

Video:

<https://youtu.be/SYq1zNKFcdI>



ROBOTICS AND SPACE

Robotics integrates a wide range of technologies, such as computing, batteries performance, power electronics, sensors, processors, artificial intelligence, to list a few.

Innovations in these technologies leads to an environment where robotics surge ahead in many emerging fields, solving a wide variety of problems where traditional robots turn out to be useless.

Robots are getting more connected. Furthermore, benefits from the cloud-computing revolution can be seen enabling remote access instructions, rather than having to be programmed as a fully autonomous unit.

One of the main robotics approach is space and transportation. While Cubesats focus on space exploration applications, Unmanned Aerial Vehicles and Autonomous Vehicles mission is to deliver more efficient ways to improve citizen's life.

The Technologies considered under this category are Autonomous Vehicles, CubeSats, Robotic Process Automation, Social Robots and Unmanned Aerial Vehicles.

Case Study: Singapore Government Smart Transportation



Summary

The Singapore government is fostering the use of autonomous vehicles to reduce pollution.

NuTonomy is a MIT-spinoff that is testing self-driving cars. In early 2016 this company was the first one to obtain permission from the Singapore government to test self-driving cars in a small area of the city (One-North district). It has now started trials with passengers.

In this case, Deep Learning is applied in the car technology for object recognition (perception).

Entity

Singapore Government

Region and location



Singapore

Applicable technologies

- Main: Robotics & Space (Autonomous Vehicles)
- Others: Artificial Intelligence (Deep Learning)

Singapore Government – Smart Transportation in depth

Singapore has the ambition to make its country the world's first true Smart Nation by harnessing technology to the fullest with the aim of improving citizens' life quality.

The Land Transport Authority (LTA) which manages urban mobility in order to provide the most efficient convenient service to its citizens established the following objectives:

- Offer a land transport network that is integrated, efficient, affordable and sustainable to meet the needs of the nation.

- Plan, develop and manage Singapore's land transport to support a high quality environment and make optimum use of mobility measures.
- Develop and implement policies to promote the mode of transport that is most appropriate to the needs of commuters. The public transport system in Singapore is efficient and well organized and allows to easily reach any place in the city.

To achieve this goals this initiative was created thanks to a partnership between Singapore's government and nuTonomy (one of MIT's subsidiaries).

Nutonomy offered its software and algorithms to be applied in a prototype of autonomous vehicle

of Singapore's Government. These software and algorithms are based on deep learning technologies applied to images or video data and other machine learning methods to allow the car to make its own decisions.

This pilot is in an experimental phase in the One-North district of Singapore and it is intended to be implemented in the city as a public resource to foster a culture of collaborative economy.

The autonomous vehicles service benefits for citizens are fewer traffic jams and less pollution. It is remarkable

that, despite the growth in car ownership rate, traffic congestion in Singapore is a rare event, unlike many of the neighboring cities such as Jakarta, Bangkok and Kuala Lumpur.

The initiative is aimed to benefit Singapore's transportation as a whole and evolve it to an integrated network of driveless vehicles that could include self-driving taxis and autonomous car sharing.

Video:

<https://www.youtube.com/watch?v=GVncM0fSELk>



Case Study: Indian Space Research Organization Indian Cubesats



Summary

The Indian Space Research Organization is the space agency of the Government of Republic of India headquartered in the city of Bengaluru. Its vision is to «harness space technology for national development», while pursuing space science research and planetary exploration.

The Indian Space Research Organization was constituted in 1969; from a low-budget, “blank-sheet-of-paper” approach, it has become one of the leader organizations in satellite launching, integration and building.

India Government – Indian cubesats in depth

The Indian Space Research Organization has become one of the foremost players in space activities (both industrial and scientific).

Some key facts:

- India currently operates one of the biggest satellite communication networks in the world: Currently, INSAT (Indian National Satellite) system provides a large number of services (in the TV and radio broadcasting, communications and meteorology sectors), supplying services to most of the Indian Territory.

Entity

Indian Space Research Organization

Region and location

India



Applicable technologies

- Main: Robotics and Space (Cubesats)
- Others: Smart Platforms (Communication Networks)

- India has developed its own technology in key areas: Currently, India has its own, both Indian-designed and Indian-built launching vehicles (Polar Satellite Launch Vehicle and Geosynchronous Satellite Launch Vehicle), cryogenic rocket engine (CE-20) and Satellite buses (specially, the Mini Satellite Buses IMS-1 and IMS-2)
- Massively successful in the satellite launching business: Currently (as of 2007), India is world leader in satellite launching services. In June 2016, India broke a record launching 20 satellites in a single launch; in 2017, there are contracts to launch more than 80 satellites. India operates mainly in

the small and light satellite segment; in this range, is the more reliable platform in the world (PSLV, with 36 consecutive successful launches so far)

- A modular approach to satellite launch: India has developed a successful integration platform (a mini satellite bus) that provides the “base functions” to satellite services (that is, power, stabilization, positioning, etc.), so different providers can create its own satellites “out-of-the-box” filling the base system with scientific camera systems, telecommunication transporters and similar systems. These base systems (India Mini Satellite System 1, up to 30 kg of payload, for micro - satellite systems, and India Mini Satellite 2, up to 200 kg of payload, for mini – satellite systems) are key elements in India’s space strategy.

A major breakthrough, and a proof of Indian’s world-class prowess in the space technology area has been the successful launching of Mars Orbiter Mission, Indian’s first mars probe.

In addition, India has a partnership program with universities around the world, encouraging students and young researchers to develop its own experiments and micro and pico satellites and to integrate them in India’s base satellite infrastructures, in order to create an Indian – led worldwide micro – satellite ecosystem.

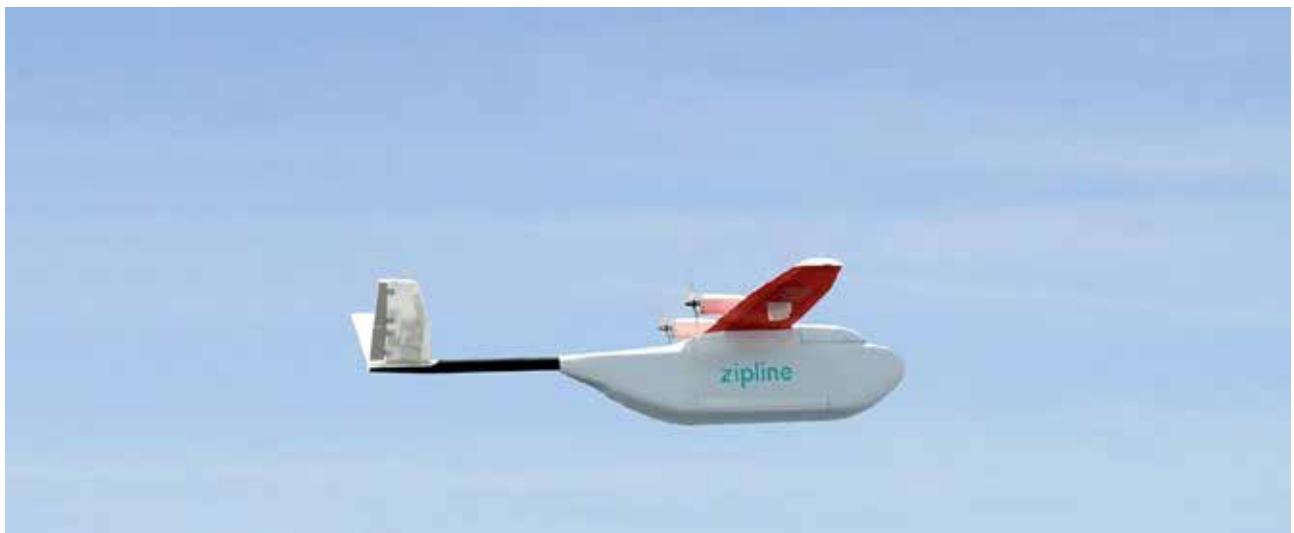
A key aspect of India’s approach to space technology is its ability to develop a world leadership in the key micro and mini-satellite launching market, and act as a “hub” for emerging initiatives all over the world.

Video:

<https://www.youtube.com/watch?v=jYFX3sVsZ7Y>
<http://www.isro.gov.in/video-gallery>



Case Study: Rwanda Government Unmanned Aerial Vehicle



Summary

Rwanda has launched the world's first national drone delivery system, which will be used to deliver blood to patients in remote areas of the country.

The drones, manufactured by California robotics company Zipline began delivering blood to 21 transfusing facilities in the western part of Rwanda, where poor roads and healthcare infrastructure have often made it difficult to reach patients in need.

Entity

Rwandan Government

Region and location



Rwanda

Applicable technologies

- Main: Robotics and Space (Cubesats)
- Others: Robotics & Space (Unmanned Aerial Vehicles)

Rwanda Government – UAV in depth

Before October 2016, Kabgayi District Hospital in Muhanga District relied on road network to deliver blood supplies, and the deliveries took between four and five hours using an ambulance.

Due to the high number of patients turning up at the facility as well as complex cases, the facility replenishes its supplies about twice a week but in the event of accidents, they require fresh supplies up to five times a week.

In this situation, Zipline announced its partnership with the Rwandan government during 2016 to find an alternative supply way using Zipline's drones. They spent several months testing its launch system at a distribution center in the Muhanga region.

Based on a distribution center 15 custom-built drones could be found. These drones, called "Zips", can fly up to 150 kilometers, round-trip and carry up to 1.5 kilograms of blood.

Hospitals connected to the supply wire can order blood via text message and have it parachuted to their location in an average of 15 minutes, eliminating the need for onboard refrigeration or insulation.

This project's most important advantage is the cut down in the time taken in delivering blood supplies to the hospitals.

Moreover, it does not require that staff from the supplying health center have to leave the hospital as it

was needed in the previous situation.

Since the very early deployment, the portfolio grown from 5 to 44 services across 9 public agencies and it is expected to continue growing in the upcoming years because of its impact providing better healthcare services to Rwandan citizens.

The personnel has been trained on using the system, improving convenience and service delivery quality where citizens living even in the remotest parts of the country can access quality public services.

Video:

<https://youtu.be/OnDpE8uSb7M>





SMART PLATFORMS

The concept of Smart Platforms arises from a world in which objects of all kinds could sense, communicate, analyse, and act or react to people and other machines autonomously, in a non-intrusive manner.

The ecosystems comprise a large number of technologies, many of which have existed for years such as Big Data platforms, Communication Networks or IoT platforms whereas others have emerged recently. While sensor technologies have been around for decades, today's sensors have become smarter, cheaper, and connected, opening up new opportunities to access real-time data produced by humans, machines, or any connected object.

In order to use such amounts of created data it is necessary to create an Information Value Loop with discrete but connected stages where an action in the world allows to create information about it, which is then communicated and aggregated across time and space to be analysed in the service of modifying future acts.

Case Study: Seoul Arisu Clean Water Leakage Detection



Summary

The Seoul Metropolitan Government (SMG) implemented a new system based on data analytics for studying the correlation between leakage points and weather conditions. Thanks to this system, 25 years of data were analyzed in order to correctly modulate pressure and reduce their leakage rate.

Moreover, the leak detection system has been highly improved with the introduction of a multi-point leak noise correlation system, which offers real-time data about leaks.

Seoul Arisu - Clean water leakage detection in depth

Historically, Seoul experienced a chronic shortage of clean water, with a water distribution network that was both insufficient and highly prone to leakage.

Beginning in the late sixties and, particularly, from 1989 on, Seoul has dramatically improved its tap water network, transforming it from an insufficient, low-quality and unreliable system to one of the best in the world.

Some milestones are:

- 1989: Launch of the Seoul Waterworks Authority.
- 1991: Accomplished 100% water supply ratio.
- 1996: Conducted the 1st phase of Advanced Water

Entity

Seoul Metropolitan Government

Region and location

Seoul (Republic of Korea)



Applicable technologies

- Main: Citizen engagement & analytics (Big Data Platforms)
- Others: Smart Platforms (Communication Networks and Internet of Things Platforms)

Treatment Research.

- 1998: Constructed Gangbuk Arisu Water Purification Centre; conducted water quality examinations for each Purification Centre.
- 1999: Conducted the 2nd phase of Advanced Water Treatment Research.
- 2001: Launched the production of Arisu bottled water.
- 2004: Registered the «Arisu» trademark
- 2006: Established one-stop, tap-water customer service.

- 2007: Adopted the Arisu Quality Conformance Test.
- 2008: Began the auto-measurement of water quality; Online real-time data disclosure; Opened the Tap Water Museum.
- 2009: Awarded the UN Public Service Awards.
- 2010: Constructed the Yeongdeungpo Water Treatment Centre; Awarded the «Water Innovation Prize» by the Tap Water Association.
- 2012: Expanded the scope of water quality testing (153-163); Acquired the NSF Certification for bottled tap water for the first time in the world; Won the consulting project to build the infrastructure in PMB Island.
- 2015: Completed the advanced purification facilities in the Purification Centres.

A specific area of improvement has been leakage reduction. The diverse causes of leakage include pipe deterioration, valve malfunctioning, poor construction, overpressure, rupture, and numerous types of physical damage to pipes. Turning to leaking pipes, the surrounding physical environments may be responsible, though leaks could also occur when unused pipes are left mounted or unsealed.

After analyzing 25 years of data on pipe leakage (1989 and 2014), the Seoul Metropolitan Government (SMG) was able to pinpoint the correlation between leakage points and weather conditions. They have

implemented a new system based on data analytics, whereby modulating the pressure, they have significantly reduced their leakage rate.

Also, for real-time detection, there is a multi-point leak noise correlation system, which offers a comprehensive solution. This device collects leak noises through the high-sensitivity sound sensors attached on gate valves, fire hydrants and meters. Using the installed program, the system conducts a complete analysis of noises and pinpoints the locations of all leaks with high precision. These points are digitised and presented in 3D graphs.

Additional measures have been implemented such as a precise flow metering (for detecting anomalous water flows at minimum consumption hours).

The radical improvement in clean water leakage has had a huge impact for citizens and the city of Seoul as a whole. The reported savings in both water and maintenance amount to not only millions of dollars yearly but also, and more importantly, a reliable source of clean water, which is a prerequisite for the continuous development of the city of Seoul.

The Seoul Government Authority has undertaken a massive, multi-year and multi-faceted effort, which today amounts for a leakage reduction from %79 in 1989 to %2.5 in 2014.

Video:

<https://www.youtube.com/watch?v=6iaySkhyq4>



Case Study: UK Government Digital Catapult Things Connected



Summary

Digital Catapult Things Connected, an innovation support programme that will ensure London is open and ready to innovate with the Internet of Things (IoT). The programme will empower digital startups and SMEs to embrace the opportunities of IoT, and help drive innovation that will transform lives across the capital.

Things Connected will initially provide 50 LoRaWAN base stations located across London to establish the UK's largest IoT LoRaWAN network. Free to use, the programme will provide a testbed to support evolving IoT technologies in its roll out. LoRaWAN is the first phase of the testbed and additional low-power wide area network (LPWAN) technologies will be included as the network develops.

UK Government - Digital Catapult Things Connected in depth

A free-to-access Internet of Things (IoT) network has gone live in London with the aim of removing cost and power barriers to start-ups creating M2M applications.

The infrastructure is powered by Low-Power Wide-Area Network (LPWAN) technology and will initially comprise 50 LoRaWAN base stations across the capital.

The broad focuses of the project include bringing together data from various sensors measuring

Entity

'Digital Catapult Things Connected' is fostered by the government-supported Digital Catapult initiative, as well as academic institutions including UCL, King's College London and Queen Mary University, along with BT and Everynet.

Region and location

London (UK)



Applicable technologies

- Main: Smart Platforms (Communication Networks)
- Others: Smart Platforms (Big Data Platforms and IoT Platforms)

pedestrian and cyclist data to provide safer route planning. Potential uses include traffic optimisation, health monitoring, as well as improving the cost effectiveness and complexity of information used for environmental analysis.

Another potential innovation could be in supporting the future development of drone delivery services, for example, by deploying and linking up micro wind and turbulence sensors to improve viability for increased

use of such technology in the capital.

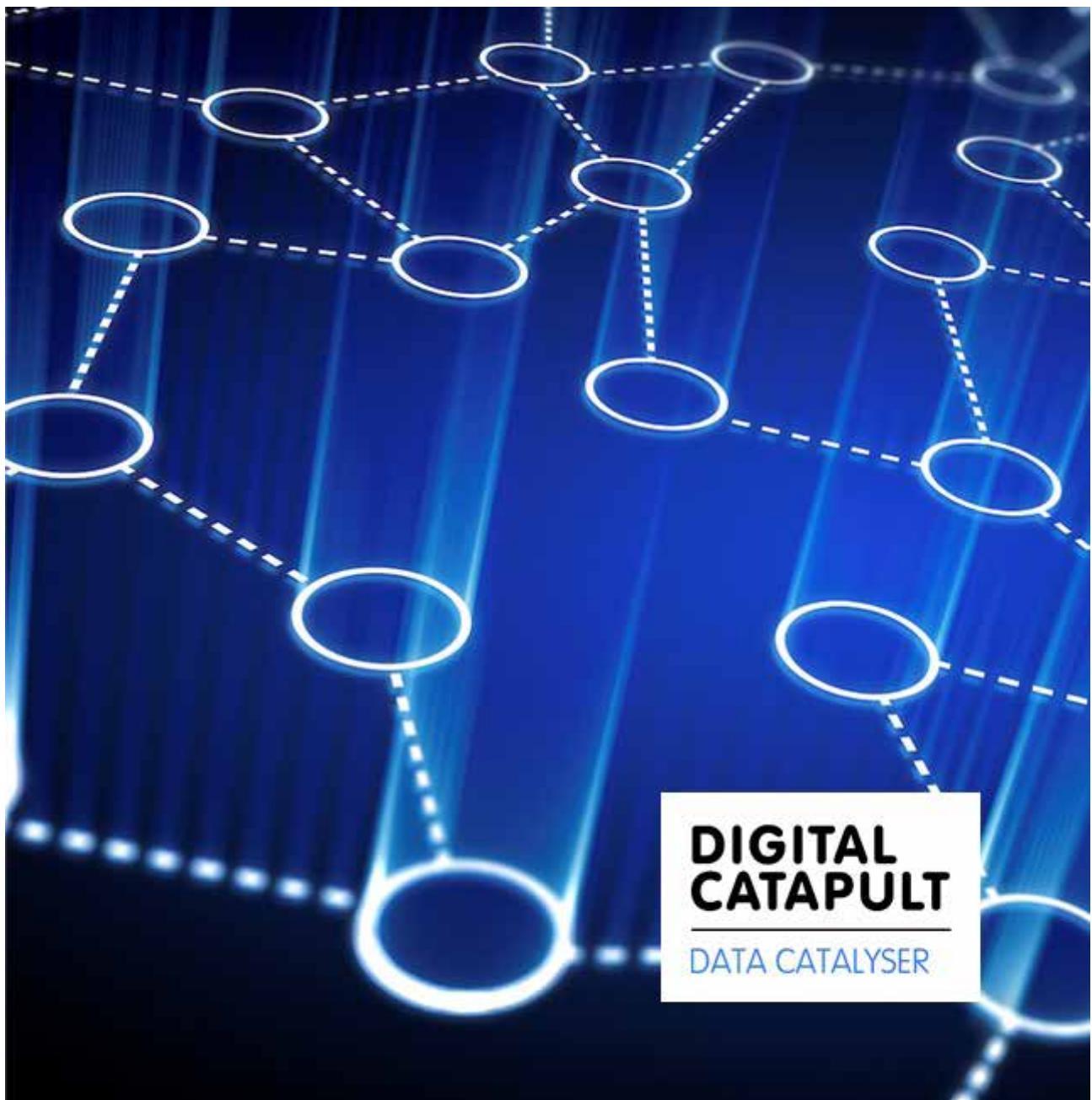
Digital Catapult hopes the network will eventually spread across the country, claiming there will be a 20£ billion market by 2020.

Things Connected has the potential to drive experimentation and innovation in IoT and to improve the lives of those living and working in the UK.

Challenge areas include but are not restricted to sustainability (i.e. energy management and environmental sensing), urban mobility (i.e. traffic and transport services), connecting communities, healthy cities and urban planning.

Video:

<https://youtu.be/HbgUGmLTBJ8?t=9>



Case Study: Dutch Government Smart City Amsterdam



Summary

Amsterdam Smart City (ASC) is the innovation platform of the Amsterdam Metropolitan Area. It challenges businesses, residents, the municipality and knowledge institutions to suggest and apply innovative ideas and solutions for urban issues. Since 2009 Amsterdam Smart City has grown into a platform comprising more than 100 partners, who are actively involved in over 140 innovative projects.

Entity

Dutch Government

Region and location

The Netherlands



Applicable technologies

- Main: Smart Platforms (Internet of Things Platforms)
- Others: Citizen engagement & analytics (Customer Engagement Hub and Social Media Analytics), Cloud and High Performance Technologies (Cloud Service / Data Brokerage Open Data) and Smart Platforms (Big Data Platforms and Communication Networks)

Smart City Amsterdam in depth

Amsterdam, as one of the world's Smart City of reference has deployed over 140 projects and pilots that enables the access to several services for citizens in order to improve their life quality. Some of the initiatives related to Internet of Things platforms are detailed below:

- Smart energy: In Amsterdam 700-900 houses are connected to a smart grid in order to be retrofitted and achieve the CO₂ reduction target (3,000 tonnes per year). This ensures affordable total living costs (rent and energy) for householders.
- Smart Lampposts: Amsterdam has around 116,000

smart lampposts that suppose a saving of € 10 billion per year in a city where 19% of the electricity consumption is because of lighting.

- Smart office: The most connected office space in the world with over 2,500 workers is located in the city of Amsterdam. With 40,000 square metres of connected devices such as 6,000 lights or coffee machines and towel despensers.
- Smart shipping traffic: Bridge opening and closing has been recently automated to improve cars and ships experiences and to reduce waiting times.

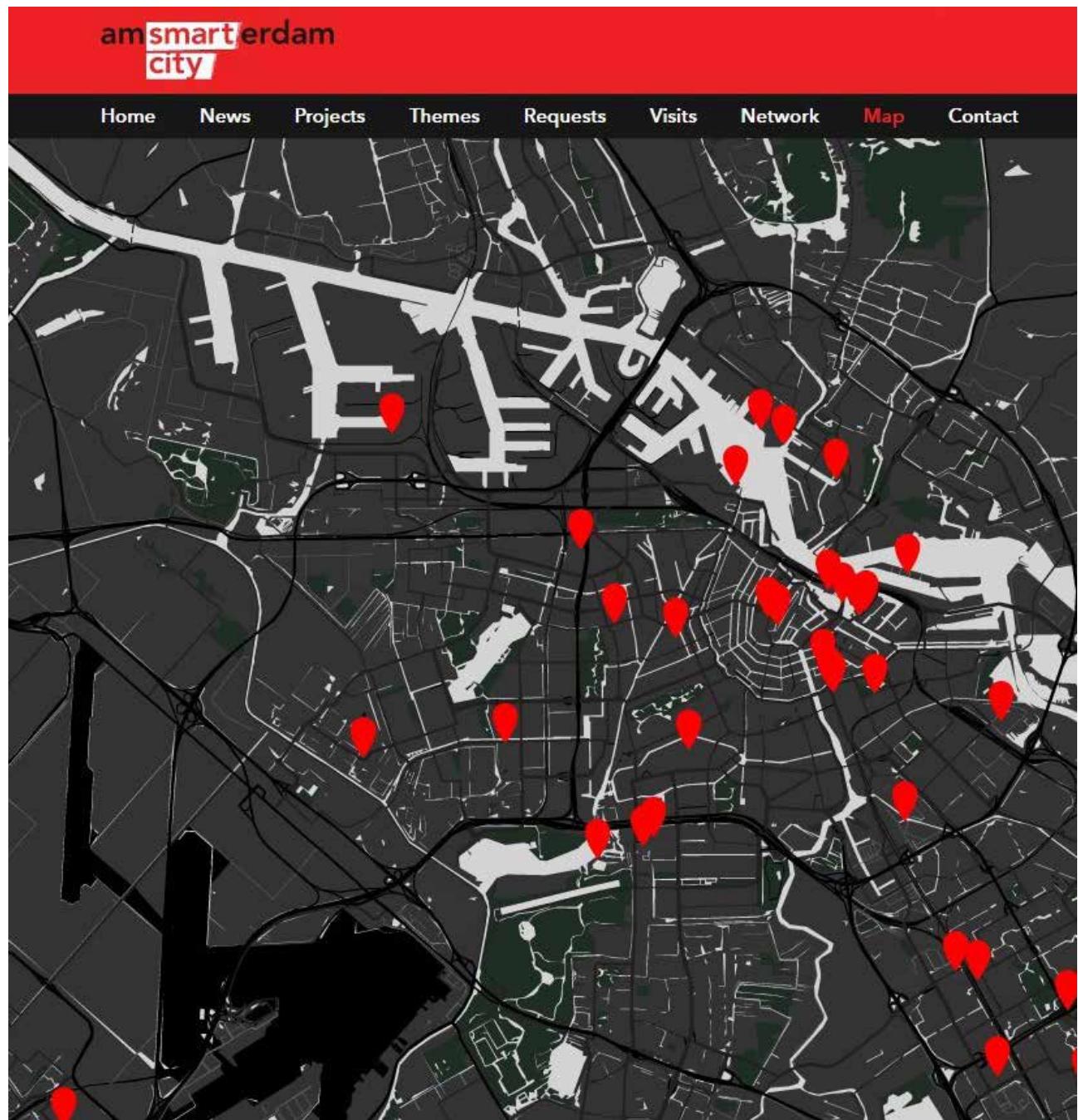
The goal is to know information about traffic congestion in real-time or predict maintenance for bridges. Cost are drastically reduced, about 80,000 euros each year per bridge.

- Smart traffic management: The city of Amsterdam now uses TrafficLink's SCM system that is connected to the traffic system of the national government. Since the implementation of intelligent traffic management, the percentage of vehicle loss hours in the Amsterdam area has dropped by 10 percent.

Amsterdam has its own 'Living Lab' (iBeacon) covering 3.4 miles where the inventors can test their products, prototypes and ideas. The continuous growth of this Lab ensures the continuous appearance of new projects and pilots related to many emerging technologies.

Video:

<https://amsterdamsmartcity.com/network/amsterdam-smart-city>



Case Study: Galician Health Service (SERGAS) Remote Care Health Service



Summary

The Galician Health Service (SERGAS) is immersed in a modernization process which includes a Health priorities Plan which addresses aspects related to the expectations of users regarding the received care service, such as, waiting times, information availability and other initiatives involving improvements and more efficient operation of health services.

One of its main objectives has been to take steps towards the remote assistance of chronic patients, as well as, those recently discharged in real-time. Therefore, more secure monitoring of patients and the environmental conditions in the hospital's rooms, in order to reduce unnecessary and costly trips between the hospital and the patients' homes.

Galician Health Service (SERGAS) – Remote Care Health Service in depth

The Galician Health Service (SERGAS) is moving towards a public healthcare model that links, to the possible extent, the health centre to the patient's home. Through the development of a bidirectional communication channel between the health service and the patient, allowing self-management of chronic processes and create a home remote care channel.

Another step has been the incorporation of the biometric values of hospitalised patients into Sofia2 platform in order to centralize the complete set of

Entity

Galician Health Service

Region and location

Galicia Autonomous Region (Spain)



Applicable technologies

- Main: Smart Platforms (Internet of Things Platforms)

historical values for the patients.

The Sofia2 IoT Platform enables seamless interaction between multiple medical systems and an array of different technological devices to engender real-time reactions to biometric information with specific thresholds for each patient and the analysis of historical information thanks to its big data features.

The solution consists on two modules:

- In-Hospital Monitoring: It stores patients' biometric readings together with all the medication they have been administered and environmental safety information, resulting in a digital lifetime repository of the medical activity of the patient.
- Remote Patient Monitoring: Remote care for patients and the senior population, allowing an unlimited number of patients to be monitored simultaneously while leaving beds and doctors available for more critical cases.

It's important to note that big efforts have been made to establish the electronic medical history and the electronic prescription so any citizen can be attended at any point of the healthcare network by any professional with all the clinical information necessary for decision making.

In this sense, other initiatives have been developed, for example, the deployment of the SITUM system for the localization and guidance of patients inside different hospitals and medical centers. Patients can be oriented within the center through a free app that is already available.

Both healthcare workforce and patients have seen the greatest benefits from the IoT platform implementation. Most of them are described below:

- Optimised hospital efficiency.
- Increased security thanks to real-time monitoring.
- Cost reduction in trips, both for patients and hospitals.
- The Smart Health Big Data Platform will contain invaluable information about SERGAS's patients over time.
- 40% estimated reduction in chronic patients' number of trips to hospital.
- 20% estimated reduction in hospital staff's number of trips.
- 30% cost saving in the amount of time dedicated to care for chronic patients by doctors and nurses.
- 20% reduction in medical consultations thanks to the electronic prescription since chronic patients don't need to visit doctors so frequently.

Video:

<https://www.youtube.com/watch?v=fN24DncHKak>



VIRTUAL WORLD

The digital experience has entered our daily lives through smartphones, tablets, cognitive expert advisors and the entertainment systems in our homes and cars, etc. Governments are being forced to develop new uses of Virtual and Augmented Reality in order to streamline their processes and improve citizens' experience.

The industrial sector recognised this technology's amazing potential decades ago and continues to expand its possibilities with technological improvements, such as the digital twin concept, which is a cloud-based virtual representation of a physical asset.

It is a paradigm shift that is redefining markets, entire industries and societies.

Case Study: Stanford University's Department of Neurosurgery – Surgical Theater's VR Visualisation Platform



Summary

Surgical Theater's Virtual Reality (VR) medical visualisation platform lands at Stanford University, Department of Neurosurgery, in the heart of Silicon Valley where medical innovation converges with technology to usher in the next-generation of patient engagement and healthcare.

Entity

Stanford University's Department of Neurosurgery

Region and location

Stanford, California (USA)



Applicable technologies

- Main: Virtual World (Virtual and Augmented Reality)

Stanford University's Department of Neurosurgery – Surgical Theater's VR Visualisation Platform in depth

As other top academic hospitals like UCLA, New York University, University Hospitals Case Medical Center, Mayo Clinic, and Mount Sinai, The Stanford University's Department of Neurosurgery has implemented the Surgical Theater's VR medical visualisation platform to reveal the importance of patient engagement and patient empowerment.

This platform combines leading-edge fighter jet flight simulation technology with the patient's own anatomy scans, using medical imaging such as MRI and CT, to create a VR reconstruction of the individual patient anatomy and pathology. The technology builds upon the traditional method of the neurosurgeon pointing out the tumor or vascular abnormality on a

flat, black-and-white 2D image used in most medical facilities.

This allows for multiple levels of interaction and immersion for the surgeon and the patient from swiping fingers across a touch screen to donning an Oculus Rift® or HTC Vive® VR headset.

Surgical Theater's Precision VR visualisation platform also delivers powerful surgical planning and navigation capabilities while providing professional education and rehearsal functionality.

Thanks to the platform a critical gap in patient education is addressed by allowing shared and better decision-making opportunities, especially for those

with language barriers, for children, for elderly and for families as they are grappling with a new and bewildering diagnosis. When wearing the VR headset, a VR-empowered patient can tour and walk into the space between vascular structures and can literally stand between arteries and the tumor.

Furthermore, the VR-empowered patient can physically walk together with the surgeon down a planned surgical path or minimally invasive corridor to obtain an understanding of the safety and benefits of less invasive surgical approaches.

Video:

<https://www.youtube.com/watch?v=8DnEadLgWCE>



FINAL REMARK

AN ETHICAL COMMITMENT FOR A RESPONSIBLE USE OF TECHNOLOGY

As we have seen throughout this report, societies today are experiencing a profound momentum of change and transformation, largely motivated by the application of disruptive technologies in almost all aspects of human life. Although this transformation can be beneficial and even necessary, it faces an important risk: empowering an instrument into a goal itself. Technology without an ethical and moral horizon is empty just as ethical and moral values would fail without a wise application of technology. Ethical commitment therefore mainly focuses on the social transformation and the promotion of human happiness thanks to a responsible use of technology for a better future.

A future in which more than half the human population will live around large cities, which will require an adaptability and resilience in the face of new challenges that we have never seen before such as climate change, water scarcity and stress, cybersecurity, etc.

International organisations, professional associations and local and national authorities all around the world actively promote the realisation of the concept of Smart Aware Communities. Understanding through this concept that the responsible application of technology to improve the quality of life of citizens is possible and beneficial, particularly providing:

- (i) Governance: wise government by enabling new forms of e-government, new modes of operational governance, improved models and simulations to guide future development, evidence-informed decision-making, better service delivery, and making government more transparent, participatory and accountable;
- (ii) Economy: smart economy by fostering entrepreneurship, innovation, productivity, and competitiveness;
- (iii) Mobility: smart mobility by creating intelligent transport systems and efficient, inter-operable multi-modal public transport;
- (iv) Environment: smart environments by promoting sustainability and resilience thanks to the development of green energy and water awareness communities;
- (v) Living: smart living by improving the quality of life, increasing safety and security, and reducing risk;
- (vi) People: smart people by creating a more informed citizenry and fostering creativity, inclusion, empowerment and participation.

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