







Roadmap for artificial intelligence and bots

Description and state of the art	
 Definition	<p>Technology field that draws upon computer science, mathematics, psychology, linguistics, philosophy, neuroscience and artificial psychology.</p> <p><i>Artificial Intelligence (AI)</i> is intelligence exhibited by machines. In computer science, an "intelligent" machine is ideally a flexible rational agent that perceives its environment and takes actions that maximize its chance of success at some goal. Colloquially, the term "artificial intelligence" is applied when a machine mimics cognitive functions such as "learning" and problem solving.[1]</p> <p>From another point of view, artificial intelligence is the science of doing by computer the things that people can do and in contrast to normal hardware and software, enables a machine to perceive and respond to its changing environment.[2]</p>
 Addressed societal /business or public sector need	<p>Business need:</p> <p>Access to public sector information</p>
 Existing solutions /applications /services	<p>There are already several examples of the use of artificial intelligence and especially chatbots in the public sector.</p> <p>Enfield London Borough Council purchased Amelia in 2016, a robot capable of making decisions and tracking customer emotions. The robot is used by the council to help improve service delivery by directing residents to correct information and helping to authenticate licenses.[3]</p> <p>Her Majesty's Revenue and Customs Agency has automated the most tedious aspect of its call centre work, opening case numbers for advisers so they don't have to search the database. The agency estimates this has reduced handling times by 40 percent and processing costs by 80 percent.[4][5]</p> <p>The Department of Homeland Security's Citizenship and</p>



	<p>Immigration and Services has created a virtual assistant, EMMA, that can respond accurately to human language. EMMA uses its intelligence simply, showing relevant answers to questions—almost a half-million questions per month at present.[6]</p> <p>To help prospective recruits understand their options, visitors to the Army website encounter SGT STAR, an interactive virtual assistant that uses artificial intelligence to answer questions, check users’ qualifications, and refer them to human recruiters.[7]</p> <p>North Carolina’s Innovation Center (iCenter) is testing chatbots to aid internal IT help desk personnel, freeing their time for more important tasks. The iCenter found that 80 to 90 percent of the tickets that its IT help desk receives are for password resets, which chatbots can perform.[8]</p> <p>Cities in the U.S. are utilizing text-based services to aid citizens and government employees: the city of Mesa, Arizona is testing a text message chatbot that can answer frequently asked questions about available services. Residents can use text messaging services to ask questions about their billing information or updating credit card information.[3]</p> <p>The Australian Tax Office deployed a chatbot called Alex in March 2016 to help citizens with questions related to taxes. Alex has already conducted more than a million conversations with citizens.[3]</p> <p>The government of Singapore has developed a Facebook chat bot to connect the public with its ministries.[9]</p> <p>To create a chatbot, there is currently an incredible amount of platforms and tools, with different complexity levels, expressive powers and integration capabilities.[10]</p> <p>Typical systems are:</p> <ul style="list-style-type: none"> • Inteliwise eGov Virtual Assistant[11] • Virtual Agents and Chatbots Directory[12]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Institut National de Recherche en Informatique et en Automatique • Centre National de la Recherche Scientifique • University of Edinburgh • University of Oxford • Imperial College of Science • Technology and Medicine





Current research activities

EU-projects:

- **e-learning:** Icarus, Infantium2.0,
- **Theories:** WhoLoDancE, AI4REASON
- **Production:** Workshop4.0, ZinkOn Growth, PREVIEW, AUTOUNIMO
- **Linguistics:** LOVE, DASMT
- **Robotic:** DREAM, MULTI-ROBOT
- **Logistic:** TIMON
- **Decision making:** SURVEIRON, CoPS
- **Search algorithms:** SSX, GRAISearch
- **Analysis:** SCaEL, CYPRES

EUREKA project (Artificial intelligence platform development)[13];

EUROSTARS project (MLB)[14], TRASPAIR[15], Pocket Pet[16], Intelligent transportation system[17], Research and development of intelligent oversight centre [18], Smartcare - expert system for better healthcare outcomes [19];

CDTI project (Spain): platform for the automatic and intelligent learning of robots software[20]

BMBF project (Germany): Hybr-iT [21];



Impact assessment

Public Sector Modernization:

- Positive impact on degree of resources (capital, personnel, infrastructure) utilization
- Better efficiency, productivity
- Higher quality of services provided
- Image modernization

Public sector as an Innovation Driver:

- Prosperity and well-being
- Better quality of health
- But, negative impact on employment

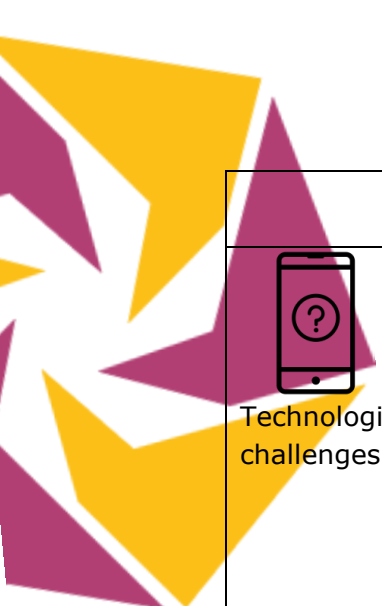
Necessary technological modifications




Potential cases use

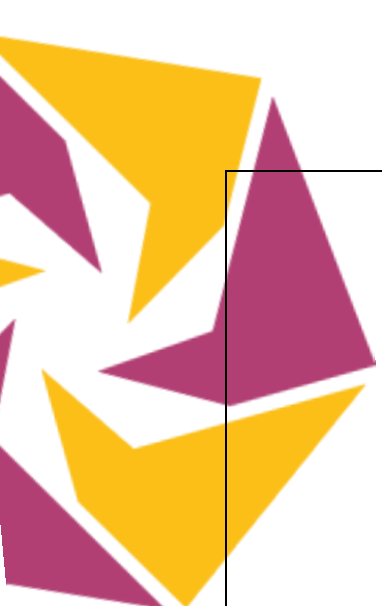
Especially in the area of artificial intelligence a lot of extremely helpful systems are thinkable, which could support the public sector in their work. Several of them are already in use in some parts of the world:

- Bots to answer simple citizen questions / automated online assistants instead of call centres with humans to provide a first point of contact
- Citizen personal agents taking action on the behalf of citizens (alerting citizens with regard to their obligations toward the Public Administration, retrieving information for them, filling out forms for them, etc.
- data mining agents finding trends and patterns in the interaction of citizens with public organisations
- Local Government applications:[22] Reporting a pothole;



	<p>Housing repairs; Missed bin collections; Getting in touch with a councillor or finding a decision;</p>
 <p>Technological challenges</p>	<p>Since its beginnings, AI research has advanced in three technology waves. The <i>first wave</i> focused on handcrafted knowledge, with a strong focus in the 1980s on rule-based expert systems in well-defined domains, in which knowledge was collected from a human expert, expressed in “if-then” rules, and then implemented in hardware.[23]</p> <p>The <i>second wave</i> of AI research from the 2000s to the present is characterized by the ascent of machine learning. Significant advances in AI have been applied to tasks such as image and writing recognition, speech understanding, and human language translation. Key to some of these successes was the development of deep learning.[23]</p> <p>Despite progress, AI systems still have their limitations. AI systems for image recognition rely on significant human effort to label the answers to thousands of examples[23]</p> <p>The AI field is now in the beginning stages of a possible <i>third wave</i>, which focuses on explanatory and general AI technologies. If successful, engineers could create systems that construct explanatory models for classes of real world phenomena, engage in natural communication with people, learn and reason as they encounter new tasks and situations, and solve novel problems by generalizing from past experience.[23]</p> <p>Current challenges are for example:</p> <p>‘Bot-speak’ and cold user experiences: While effective at delivering news, the conversation with the some bots have little feeling or personality associated with it. When engaging with bots, people don’t need to feel as if they’re interacting with a human, but they do need to feel as if they’re being heard. [24]</p> <p>Bots can’t relate to humans: Bots are designed to follow a specific path and for the most part, they rarely accommodate deviations away from a programmed script. Unfortunately for the user, this means many bots can’t understand even the most basic commands or responses if they fall outside of the programmed sequence. This results in a repetitive and unfulfilling experience.[24]</p> <p>Decide on how long should a bot wait to understand human Different people have their own way of typing a message (short sentences, long sentences, really long</p>














sentence in a chat bubble, multiple very short sentences in multiple chat bubble...) When should a bot reply?[25]


Limitations of Natural Language Processing: The current state of natural language Processing is not that advanced to tackle everything, e.g. mixing of local language.[25] When trying to build an ambitious chatbot, which is able to handle complex conversations and take actions (i.e payments), one cannot rely 100% on the platforms and custom natural language processing development is needed. Recent advancements in Deep Learning techniques may come to be of great help in the near future.[10]






Necessary activities (in or for the public sector)

 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>To create a chatbot or to use artificial intelligence in the public sector well-trained personnel with a background in IT systems is needed.</p>
 <p>Advanced adapted infrastructure needed or ICT</p>	<p>Open task</p>	<p>Running a complete infrastructure for chatbots on one's own servers is quite complex and expensive but there are some ready solutions especially for bots, like:[26]</p> <ul style="list-style-type: none"> • Microsoft Azure Bot Services • Microsoft Cognitive Services • Google cloud • PaaS form Google App Engine • Amazon Lex <p>However, when relying on services of third parties data protection and privacy issues have to be taken into account.</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>The use of chatbots may automate work and result in labor displacement.[3]</p> <p>Thus, on the long run there will be mayor changes regarding the tasks of the personnel and also the type of personnel needed in the respective public sector organization.</p>
 <p>Promotion information stakeholders necessary / of</p>	<p>Open task</p>	<p>Especially people above 35 years might be reluctant to talk to a chatbot. However, in 2015, human raters used text input to chat with an unknown entity, then guessed whether they had been chatting with a human or a machine. The bot called Eugene Goostman fooled more than half of the human raters into thinking they had been talking to a human being.[27]</p>






		Even though, it might be necessary to promote artificial intelligence and chatbots - to take the fears of the citizens seriously and provide information and explanations.
 Need to deal with cyber security issues	Open task	As chatbots become ubiquitous, regulators need to think about developing rules to manage security and privacy concerns associated with the use of these new tools. Hackers and scammers could use chatbots to gather valuable personal information by contacting organizations and posing as clients. Similarly, hackers and scammers can design bots to target unsuspecting users. The issues of security and privacy will become more complicated as chatbots carry out more tasks and transactions.[3]
 New or modified legislative framework or regulations necessary	Open task	<p>The increased possibilities of interpenetration between human and artificial intelligence systems might trigger a nuanced set of tensions or risks related to human safety, privacy, integrity, dignity, autonomy, and data ownership.[28]</p> <p>According to the European Parliament's European Added Value Unit six crosscutting key regulatory themes affect developments in the area of robotics and artificial intelligence:[28]</p> <ul style="list-style-type: none"> • rules on ethics; • liability rules; • connectivity, intellectual property, and flow of data; • standardisation, safety and security; • education and employment; • Institutional coordination and oversight.
 Development of a common standard necessary		Most chatbots at the moment are used locally or for a specific purpose, so that it is not necessary to develop a common standard.
 Need for a more	Open task	<p>Running a complete infrastructure for chatbots on their own servers is quite complex and expensive but there are some ready solutions especially for bots, like:[26]</p> <ul style="list-style-type: none"> • Microsoft Azure Bot Services


<p>economical solution</p>		<ul style="list-style-type: none"> • Microsoft Cognitive Services • Google cloud • PaaS form Google App Engine • Amazon Lex
 <p>Ethical issues</p>	<p>Open task</p>	<p>Chatbots may widen digital divide, depending on who is able to access them.[3]</p> <p>A big privacy concern is also that when the public sector is shifting data control from the users' hands to Facebook's, Google, and Microsoft's.[29]</p> <p>As public agencies increasingly adopt chatbots, they need to think critically about the issue of liability when the systems act unexpectedly.[3]</p> <p>The Science and Technology Committee of the House of Commons in 2016 therefore recommended to establish a standing Commission on Artificial Intelligence, to examine the social, ethical and legal implications of recent and potential developments in AI.[30]</p> <p>Ethical issues of artificial intelligence in general are:[27]</p> <ol style="list-style-type: none"> 1. Unemployment. What happens after the end of jobs? 2. Inequality. How do we distribute the wealth created by machines? (<i>how do we structure a fair post-labour economy?</i>) 3. Humanity. How do machines affect our behaviour and interaction? (<i>e.g. tech addiction</i>) 4. Artificial stupidity. How can we guard against mistakes? 5. Racist robots. How do we eliminate AI bias? (<i>e.g. when the AI system has been made by biased people</i>) 6. Security. How do we keep AI safe from adversaries? (<i>e.g. cybersecurity aspects</i>) 7. Evil genies. How do we protect against unintended consequences? (<i>What if artificial intelligence itself turned against us?</i>) 8. Singularity. How do we stay in control of a complex intelligent system? (<i>the point in time when human beings are no longer the</i>

		<p><i>most intelligent beings on earth.)</i></p> <p>9. Robot rights. How do we define the humane treatment of AI? (<i>Could we consider a system to be suffering when its reward functions give it negative input?</i>)</p>
 Societal issues	Open task	<p>The use of chatbots may automate work and result in labour displacement.^[3]</p> <p>The Reform thinktank said use of websites and artificially intelligent "chat bots" would remove the need for 130,000 Whitehall administrators, around 90% of the total, by 2030, saving £2.6 billion a year.^[31]</p>
 Health issues		<p>No reference has been identified regarding health issues of artificial intelligence and bots in the area of public sector access.</p>
 Public acceptance		<p>The prospect of replacing humans with machines, however relevant or appropriate it might be to specific tasks, is also going to stir up opposition; as will the reluctance of many people to interact with a machine rather than a human.^[32]</p>

Roadmap for augmented reality (AR)

Description and state of the art	
 <p>Definition</p>	<p>Augmented Reality (AR) is the real-time use of information in the form of text, graphics, audio, video, GPS data and other virtual enhancements integrated with real-world objects, whose elements are thus augmented.[33] It is this 'real world' element that differentiates AR from virtual reality, which in contrast replaces the real world with a simulated one. Augmentation is conventionally in real time and in semantic context with environmental elements.</p> <p>With the help of advanced AR technology, the information about the surrounding real world of the user becomes interactive and digitally responsive. Information about the environment and its objects is overlaid on the real world. This information can be virtual or real. Overall, AR brings out the components of the digital world into a person's perceived real world and enhances one's perception of reality.[34]</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Experiential education and training</p>
 <p>Existing solutions /applications /services</p>	<ul style="list-style-type: none"> • The technology for visual augmentation is already in use, especially by private persons for gaming purposes • There are several databases of augmented reality apps for the classroom in the internet, e.g. [35–37] – some examples are:[38] <ul style="list-style-type: none"> ○ Quiver (get 3d-pictures from textbooks) ○ Elements 4 D (visualisation in chemistry) ○ Blippar (visualisation of the Brainspace magazine) ○ Arloon Plants (watch growing plants) ○ Aurasma (create ones one augmented reality experience) ○ Math alive (visualization of mathematics) • In general the following forms of AR are used in the classroom:[37] <ul style="list-style-type: none"> ○ AR technology has an ability to render in 3D model anything that may be hardly visualized in a classroom, at a computer, in minds of students. ○ Including AR into lessons may help educators directly involve students into the studying



	<p>process by interacting 3D model. Taking part in such kind of things helps motivate students</p> <ul style="list-style-type: none"> o AR books provide deeper understanding of complex content. It also helps making the process of learning brighter and engaging. <ul style="list-style-type: none"> • The French Ministry of National Education was also expressing their support of augmented reality technologies in the classroom. In their revised national curriculum, the Ministry included AR as a recommended technology to be used in middle school technology courses.[39] • AR training is also already in use the automotive industry (BMW, VW [40]) or in the printing industry [40]. Other educational apps are Construct3D for students of mechanical engineering or AR apps for students of chemistry, anatomy or astronomy.[34] • Fire Departments are using a mobile Augmented Reality Training Unit made by Resolve Fire & Hazard Response, Inc. to train participants to fight fires.[41] • Brain Power[42] is working to teach life skills to children and adults on the autism spectrum • Eye Decide[43] allows healthcare professionals to demonstrate how certain conditions impede eyesight • VR Dentist[44] is a dental app that uses virtual and augmented reality for educational purposes • The "Augment" augmented reality (AR) app and platform enables students and teachers to visualize 3D models (e.g. used in career tracks like architecture, engineering, 3D animation and design, medical sciences)[39] • AR is also used in military training: In 2009 the first augmented reality training system was demonstrated for US Warfighters in what the military calls its Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD).The 36 Million dollar experiment allowed soldiers to train at home to prepare for small, urban and borderless conflicts around the world.[41]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Centre National de la Recherche Scientifique • Ethniko Kentro Erevnas Kai Technologikis Anaptyxis, Teknologian Tutkimuskeskus VTT • Technische Universität Graz • Technische Universiteit Delft





Current research activities

Research activities for AR applications in education:

- ARISE[45]
- MOBILE AUGMENTER[46]

Current Research activities for AR in general:

REALITY (eyewear), VOSTARS (medical domain), LARA (for Galileo and EGNOS), AEROGLOSS (aviation), Augmented Commerce (e-commerce), iMARECULTURE (cultural heritage), TARGET (e.g counterterrorism), SPARK (prototyping), DBRLive (cameras), INSITER (energy-efficient buildings), Wear3D (wearables), ARVisS (medical domain), MARWIN (for welding installations), MARCUS (urban settings)

National projects: Overview – virtual technologies (BMBF)[47], AVILUS, AVILUSplus[48], ViERforES[49], AR4DOC [50], ARVIDA [51], AUGUR [52], MIRACLE [53], SMART Vidente [54], MARIN2 [55],

BMBF:[56]

AR-UROLO, VIERforES II, Kognit, ENDOGUIDE, E! 5547, TOUAREG, ARinFLEX, ERANET, MANUNET, ARSGuide, itsowl, MMI, SPIRIT, THIN but Great Silicon 2 Design Objects, Professionelles Wireless Industrie LAN,EFA2014/2

BMW:[56]CRUMBS, EXIST research transfer

EUREKA projects: COMINDED[57], MOVAR[58], HIVIP[59], AR-LEAN[60], HDF DOR CSF[61, 62], Pocket Pet[16]

EUROSTARS projects: [63], TouAREG[64], HISARTOUR[65], CAMILIS[66], ORBIPS[67], LBSAAS[61],



Impact assessment

Public sector modernization:

- Efficiency and productivity

Public sector as innovation driver:

- Quality of education
- Equity & inclusiveness
- Public safety
- Transport infrastructure

Necessary technological modifications



Potential use cases

- Surgeon could use AR to learn e.g. open-heart surgery without risking patient's life[68]
- AR could simulate hazardous workplace conditions (e.g. in the construction industry)[68]



Technological challenges

Marker-based AR as mentioned in the results section is the most used approach for supporting the development of AR learning experience, followed by the location-based AR. A possible explanation for this result is that currently **the tracking process of markers is better and more stable compared to the marker-less tracking techniques.** Besides that one of the advantages of marker-based AR is the facility of implementation due to the available libraries which support the development process. There is a **challenge around the improvement of recognition algorithms for human forms** as a promising feature in the process of achieving more immersive and not intrusive AR learning experiences.[69, 70]

Accessibility and usability of the AR learning experiences are two important issues to be addressed in future research since few studies have reported research on this field. Further research need to be undertaken in usability studies for AR applications in education as well as guidelines for designing AR-based educational settings.[70]

The evolution of AR environment development tools in the last decade has been considerable; today there is a range of solutions available. Nevertheless, these solutions **still require a high technical knowledge and/or considerable time to generate content**, which makes it a challenge to create AR educational environment and to generate content in an easy and effective way. [71]

Necessary activities (in or for the public sector)



Development of a specific training necessary

Open task

The advantage of Augmented Reality is that the learning experiences can be **as easy or as complex as one wants.** It is possible to create own apps or download the numerous already-made apps connected to various content.[72] But although AR is very attractive, it is quite complicated to introduce it in the educational system and adapting it, because most of the people are **accustomed to a traditional way** of teaching; a change is needed, but above all, training is needed, because with it, the use of all these devices will come to better meet the needs of education that we have right now.[73]







Advanced or adapted ICT infrastructure needed













Modern mobile computing devices like **smartphones and tablet computers** contain these elements which often include a camera and MEMS sensors such as accelerometer, GPS, and solid state compass, making them suitable AR platforms.[74]

Other more advanced displays of AR information are e.g.-head-mounted displays, eyeglasses or contact lenses.[74]



Thus it depends on the form of education or

		<p>training needed. For basic education in the classroom smartphones or tablets are sufficient, but for a more specialised training for e.g. medical students more advanced displays are needed.</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>AR-enhanced content has to be developed as part of a unified pedagogical philosophy and teaching strategy. AR is not something you can simply patch to existing curricula as a way of making children and teenagers more excited about going to class. A proper introduction of AR in the world of education will force a lot of programs to be redesigned from scratch and re-developed with the possibilities of the technology fully in mind.[75]</p>
 <p>Promotion / information of stakeholders necessary</p>		<p>A recent survey by Gfk and Samsung found 85% of teachers agree that virtual reality would have a positive effect on their pupils. They believe it would be an asset to help students better understand learning concepts and collaborate in the classroom, and see it as a way to allow students to engage in new experiences related to course content via virtual field trips to faraway places or historical events. Eighty-four percent of teachers believe that virtual reality would increase student motivation too.[76]</p>
 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>For example the following issues have to be dealt with when using AR for education and training:</p> <ul style="list-style-type: none"> • Illegal recording and theft of user behaviour data – hackers recording users’ behaviour in their VR/AR environment and threaten to publicly release the recording unless a ransom is paid • Interjection of information or data into VR/AR to mislead or entice users into selecting items that exfiltrate personal identifiable information • Using fake VR/AR applications that steal personal information or exfiltrate behavioural data • Replacing learning or training content with malicious content or malicious applications to deceive users about the real world • Always-on cameras and other sensors will also create a privacy risk for bystanders [77, 78]

 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>Especially when dealing with geospatial data the following areas have to be covered by regulations or a legal framework:</p> <ul style="list-style-type: none"> • Privacy • Intellectual Property Rights (e.g copyright aspects) • Data Quality/Liability • National Security
 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>There is no common standard on how to deploy AR applications for education and training. However, there are some common approaches that are followed by a large number of studies. One of the most common approaches is to use AR to augment the content of books where traditional educational or training material is explained in the form of text and images. The content used for the augmentation may cover a wide range of multimedia elements (3D models, animations, videos, webpages, etc.) and also several means of interaction that provide an added value to the books.[79]</p>
 <p>Need for a more economical solution</p>		<p>Chen and Tsai[80] in particular highlight the low cost in executing manpower and moderate costs for de-signing and renewing the courses. Andujar et al.[81] agree on this benefit, especially for virtual laboratories. They add that AR applications not only reduce direct costs, such as needed materials, but also time for preparing classes. While AR technology is accompanied with high acquisition cost, this investment is most likely to pay off in the long term.[82]</p>
<p>Dealing with challenges</p>		
 <p>Ethical issues</p>	<p>Open task</p>	<p>There are some (individual) privacy concerns – probability of access to information that one should not readily possess about a given person.</p>
 <p>Societal issues</p>	<p>Open task</p>	<p>No literature regarding societal issues and the use of augmented reality in education has been found. However, there might be issues regarding the technologisation and digitalisation of society in general. It is also necessary that the students do not become too dependent on technology.[71]</p>

 Health issues		No issues identified in this area.
 Public acceptance		<p>A nationwide survey conducted by Samsung (US) in June of 2016 found that the education industry is more than ready for virtual reality and augmented reality learning. According to the survey, teachers and students alike had very positive notion about this technology</p> <ul style="list-style-type: none"> • 68% of Teachers who would like to use the Technology • 86% of Teachers find it challenging in keeping students engaged and interested in the topic • 93% of teachers surveyed believe that their students would be excited to use VR <p>The findings of a recent study[83] suggest that the parents see that there are a lot of benefits in using a technological competitive tool based on AR.</p>

Roadmap for big data and data analytics

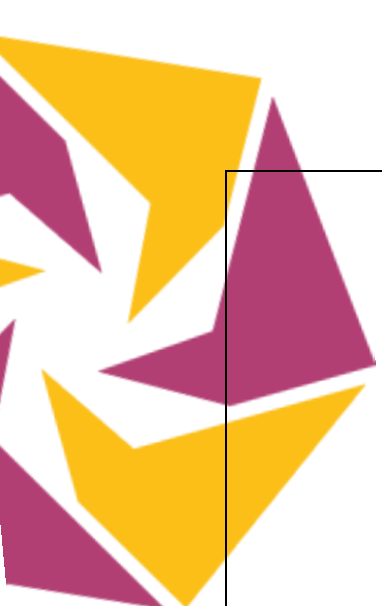
Description and state of the art	
 <p>Definition</p>	<p><i>Big Data</i> is a term for data sets with sizes and complexity beyond the ability of commonly used software tools to capture, curate, manage and process data within a tolerable elapsed time.</p> <p>According to Gartner’s definition, Big data is high volume, high velocity, and/or high variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation[84]. That definition, which includes the 3Vs (Volume, Velocity, Variety) has been recently complemented to include also Value of data as well as Veracity, coining in this manner a 5V Big Data definition.</p> <p>The term often refers simply to the use of Big Data Analytics to collect, organize and analyse large sets of data to discover hidden patterns, unknown correlations and other useful information[85].</p> <p><i>Data Analytics</i> refers to the discovery, interpretation, and communication of meaningful patterns in data, based on the simultaneous application of statistics, computer programming and operations research to quantify performance. It further often favours data visualization to communicate insight. The goal of Data Analytics (big and small) is to get actionable insights resulting in smarter decisions and better business outcomes[86]. Data Analytics can be descriptive (explaining in more detail a phenomenon which is represented with data), predictive (trying to forecast the future behaviour of a system for which past and present data is available) or prescriptive (targeting the prediction of the impact of the behaviour of a system in a future scenario)).</p> <p>Data analytics are closely related with Big Data, as the advent of the latter propelled the rapid development of novel analytics methods, capable of handling bigger data loads and of providing more evidence-based results with less uncertainty due to the bigger data samples available.</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Inclusive well-being and health</p>



Existing
solutions
/applications
/services

Several big-data platforms and infrastructure are already in use in the Healthcare sector:

- **Philips HealthSuite** Digital Platform provides a cloud-based infrastructure for connected healthcare[87, 88]
- **European Medical Information Framework (EMIF)**[89]
- **Open PHACTS Discovery Platform**[90]
- **NIH Big Data to Knowledge (BD2K)** initiative[91]
- **Asthmapolis** (GPS-enabled tracker that monitors inhaler usage by asthmatics)[92]
- **Ginger.io** (mobile application for patients with diabetes for example to assist with behavioral health theories)[92]
- **mHealthCoach** (supports patients on chronic care medication, providing education and promoting treatment adherence through an interactive system)[92]
- **RiseHealth** (customized accountable-care-organization dashboard)[92]
- four hospitals which are part of the **Assistance Publique-Hôpitaux de Paris** have been using data from a variety of sources to come up with daily and hourly predictions of how many patients are expected to be at each hospital[93]
- **Blue Cross Blue Shield** have started working with big data experts at **Fuzzy Logix** and have been able to identify 742 risk factors that predict with a high degree of accuracy whether someone is at risk for abusing opioids[93]
- **University of Florida** made use of Google Maps and free public health data to prepare heat maps targeted at multiple issues, such as population growth and chronic diseases[93]
- **Cancer Moonshot program:** Medical researchers can use large amounts of data on treatment plans and recovery rates of cancer patients in order to find trends and treatments that have the highest rates of success in the real world. For example, researchers can examine tumor samples in biobanks that are linked up with patient treatment records.[93]
- **Precision medicine initiative** launched by President Obama[94]
- **European Medical Information Framework (EMIF)**[95]
- **Open Phacts Discovery Platform**[96]
- **Flatiron Health** has developed a service called the OncologyCloud, based on the idea that 96% of potentially available data on patients with cancer is not yet analyzed. It aims to take this data gathered during diagnosis and treatment, and make it available to clinicians to further their study.[97]
- **Comet K-Project DEXHELPP** – AT[98]
- **The Shared Care Platform** – DK[98]
- **E-Estonia** – National Identity Scheme – EE[98]
- **AEGLE** (An analytics framework for integrated and



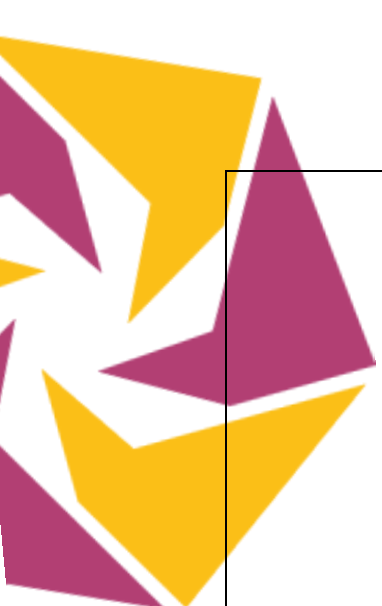
personalized healthcare services in Europe) – UK, IT, GR, SE, BE, NL, PT, FR[98]



- **The Business Intelligence database system** – GR[98]
- **PASSI** (Progressi delle Aziende Sanitarie) – IT[98]
- **Arno Observatory** – IT[98]
- **The Swedish Big Data Analytic Network** – SE[98]
- **Clinical Practice Research Datalink (CPRD)** – UK[98]
- **Sentinel Stroke National Audit Programme (SSNAP)** – UK[98]
- **Hospital Episode Statistics (HES)** – UK (England)[98]
- **The YODA Project** (Yale University open data access) – US[98]
- **FDA Adverse Event Network Analyser** - US[98]
- **CEPHOS-LINK** – FI, AT, RO, NO, SI, IT[98]
- **Twitter (Adverse drug reactions and public health)** – International[98]
- **Flatiron** – US[98]
- **UK Biobank** – UK[98]
- **Semantic Data Platform for Healthcare (SEMCARE)** – DE, NL, AT, UK, ES[98]
- **Integrated BioBank of Luxembourg (IBBL)** – LU[98]
- **Spanish Rare Diseases Registries Research Network (SpainRDR)** – ES[98]

The solutions listed below[99] are related to the platforms and initiatives listed under big data above, but have their focus on (big) data analytics in health care:

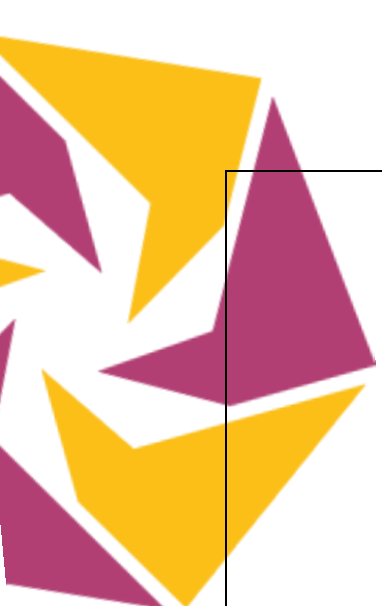
- The **Hadoop Distributed File System (HDFS)**: HDFS enables the underlying storage for the Hadoop cluster. It divides the data into smaller parts and distributes it across the various servers/nodes.
- **MapReduce**: MapReduce provides the interface for the distribution of sub-tasks and the gathering of outputs. When tasks are executed, MapReduce tracks the processing of each server/node.
- **PIG and PIG Latin** (Pig and PigLatin): Pig programming language is configured to assimilate all types of data (structured/unstructured, etc.).
- **Hive**: Hive is a runtime Hadoop support architecture that leverages Structure Query Language (SQL) with the Hadoop platform. It permits SQL programmers to develop Hive Query Language (HQL) statements akin to typical SQL statements.
- **Jaql**: Jaql is a functional, declarative query language designed to process large data sets. To facilitate parallel processing, Jaql converts “high-level” queries into “low-level” queries” consisting of MapReduce tasks.
- **Zookeeper**: Zookeeper allows a centralized infrastructure with various services, providing synchronization across a cluster of servers. Big data analytics applications utilize






	<p>these services to coordinate parallel processing across big clusters.</p> <ul style="list-style-type: none"> • HBase: HBase is a column-oriented database management system that sits on top of HDFS. It uses a non-SQL approach. • Cassandra: Cassandra is also a distributed database system. It is designated as a top-level project modelled to handle big data distributed across many utility servers. It also provides reliable service with no particular point of failure and it is a NoSQL system. • Oozie: Oozie, an open source project, streamlines the workflow and coordination among the tasks. • Lucene: The Lucene project is used widely for text analytics/searches and has been incorporated into several open source projects. Its scope includes full text indexing and library search for use within a Java application. • Avro: Avro facilitates data serialization services. Versioning and version control are additional useful features. • Mahout: Mahout is yet another Apache project whose goal is to generate free applications of distributed and scalable machine learning algorithms that support big data analytics on the Hadoop platform. <p>From industry side big data systems such as IBM Watson, Cloudvara and Hortonworks exist, but the industry is still in the pioneering stages.[100]</p>
 <p>Main actors regarding R&D of this technology</p>	<p>Big data:</p> <ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V., • Atos Spain SA, • Universidad Politecnica de Madrid, • Deutsches Forschungszentrum für Künstliche Intelligenz GmbH, • University College London <p>Data analytics:</p> <ul style="list-style-type: none"> • Centre National de la Recherche Scientifique • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • University College London • University Of Oxford • University Of Manchester
 <p>Current research activities</p>	<p>Big data:</p> <p>AutoMat, BACI, BD2Decide, BIG, BigDataEurope, BigStorage, BYTE, CIMPLEX, CoherentPaaS, DAIAD, DATA SIM, datACRON, DEDALE, EDSA, ENLIGHT-TEN, EO4wildlife, EoT, ERA-PLANET, EUDAT2020, EuDEco, EXCELL, FERARI, FREME, GROWTHCOM, iKaaS, INDIGO-DataCloud, INSIGHT, i-PROGNOSIS, L3MATRIX, LeanBigData, LinDA, MixedEmotions, MUSING,</p>





	<p>OCEANDATAMODELS, PANORAMIX, PETRA, PHEME, PROTEUS, RETHINK big, SAGE, SEE.4C, SENSATION, SoBigData, STREAMLINE, TOREADOR, TrendMiner, VaVeL, VELAССo, VICINITY BigDieMo (BMBF, DLR, PTKA)[98] Big data projects (BMBF):[99] News-Stream 3.0, iPRODIGT, BigPro, BDBSec, FEE, GeoMultiSens, HUMIT, BigGIS, AGATA, ABIDA [100]</p> <p>BMW projects:[3] iTESA, PRO-OPT, SmartEnergyHub, Fast Genomics, EnOB: BigData, NetzDatenStrom, LeichtFahr EUROSTARS projects: WINDELIN [101], PBD[102], ReProsis[103]; CDTI (Spain):SISAMED[104] The British government has announced a joint project with IBM[105] Digital Agenda Germany[106]</p> <p>Big data competence centres (BMBF)[107] Big-Data research (BMBF)[107]</p> <p>Data analytics: There are 89 EU research projects in the area of 'data analytics'. For the public sector, the following projects might be relevant: ASGARD (analysis of raw data), DataBio (bioeconomy), PULSE (participatory urban living), BIMEDA (medial domain), NICHE (healthcare), AEGLE (healthcare), AEGIS (public safety), BYTE (societal externalities), CityPulse (smart cities) BMBF:[3] LINDA, CODA, SELFPASS, Smart Urban Services, STEPS, Wachstumskern Potenzial - iLaP - B, E! 10196 MoVieStA, EINS3D SMICE, FLORIDA, Visual Analytics for Security Applications</p> <p>BMW:[3] SERVICE-FACTORY, EMuDig 4.0, MIA, PRO-OPT</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Sustainability • Quality of Services Provided <p>Public sector as an innovation driver:</p> <ul style="list-style-type: none"> • Entrepreneurship • Innovation • Prosperity and well-being • Quality of health • Public Safety • Transport Infrastructure



Necessary technological modifications



Potential cases

use

The following areas in healthcare will most benefit from the application of big data technologies:[101]

Healthy living (prevention, health promotion)

- Lifestyle support
- Better understanding of triggers of chronic diseases for effective early detection
- Population health
- Infectious diseases

Healthcare

- Precision Medicine
- Collecting patient reported outcomes and total pathway costs for value based healthcare
- Optimizing workflows in Healthcare
- Infection prevention, prediction and control
- Social-clinical care path
- Patient support and involvement
- Shared decision support
- Home care
- Clinical research

More specific examples are:


Organizations would be able to identify potential health issues and alert a care manager to intervene. For example, if a patient's blood pressure spikes, the system will **send an alert** in real time to a care manager who can then interact with the patient to get his blood pressure back into a healthy range.[102]

Another important future use is **predictive analytics**. The use cases for predictive analytics in healthcare have been limited up to the present because we simply haven't had enough data to work with. Big data can help fill that gap.[102]

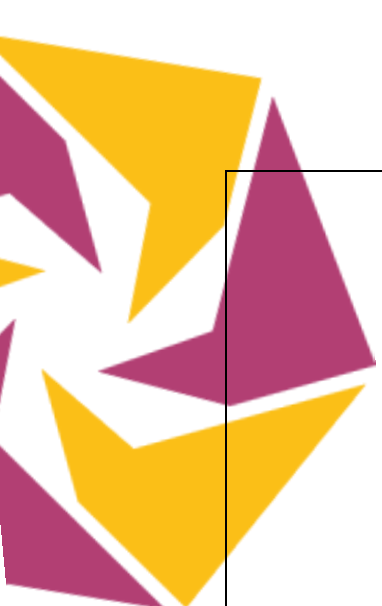
One example of data that can play a role in predictive analytics is **socioeconomic data**. Socioeconomic factors influence patient health in significant ways. Socioeconomic data might show that people in a certain zip code are unlikely to have a car. There is a good chance, therefore, that a patient in that zip code who has just been discharged from the hospital will have difficulty making it to a follow-up appointment at a distant physician's office.[102]

Another use for predictive analytics is predicting the **"flight path" of a patient**. Leveraging historical data from other patients with similar conditions, predictive algorithms can be



	<p>created using programming languages such as R and big data machine learning libraries to faithfully predict the trajectory of a patient over time.[102]</p> <p>Healthcare applications would benefit from processing and analysis of multimodal data. The fusion of different health data sources could enable the study of phenotypes that have proven difficult to characterize from a genomic point of view only.[101]</p> <p>Analysis of lifestyle data collected from apps on smartphones can be used within (learning) recommender systems that help monitor patients, raise alarms, or give advice for the better handling of a disease.[101]</p> <p>The use of knowledge bases constructed from sophisticated ontologies has proven to be an effective way to express complex medical knowledge and support the structuring, quality management, and integration of medical data.[101]</p>
 <p>Technological challenges</p>	<p>Data quality:[101] As the complexity of operations grows, with new analysis methods being developed quite rapidly, it becomes key to record and understand the origin of data which in turn can significantly influence the conclusion from the analysis.</p> <p>Cleaning:[103] Dirty data can quickly derail a big data analytics project, especially when bringing together disparate data sources that may record clinical or operational elements in slightly different formats. Data cleaning ensures that datasets are accurate, correct, consistent, relevant, and not corrupted in any way.</p> <p>Data quantity:[101] There is a need to deal with this large volume and velocity of data to derive valuable insights to improve healthcare quality and efficiency. To enhance scientific analysis and relevant applications of Big Data in Health it is recommended to adapt and expand existing Big Data sources (e.g. data repositories in hospitals) in order to include necessary information not yet captured (e.g. biomedical data) and to complement them with newly explored sources.[98]</p> <p>Multi-modal data:[101] The combination and analysis of multi-modal data poses several technical challenges related to interoperability, machine learning and mining. Integration of multiple data sources is only possible if there are on the one hand, de jure or de facto standards and data integration tooling, and on</p>





the other hand, methods and tools for integrating structured, unstructured (textual, sound, image) data.

Data access:[101]

There is a high degree of fragmentation in the health sector: collected data is not shared among institutions, even not within departments. This leads to the existence and spread of different isolated data silos that are not fully exploited.

Access to complementary sources of Big Data enables improved analytical insights and facilitates data analysis. To utilize this asset, it is recommended to support secure open use and sharing of government data, non-proprietary private data, and data of different healthcare providers for research in public interest on a national and international level.[98]


Healthcare knowledge:[101]

This knowledge exists in books and research papers, but also in the heads of healthcare professionals. New approaches are needed that bring together big data and knowledge, such that knowledge can be used to make better sense of data, and data can be used to generate more knowledge.

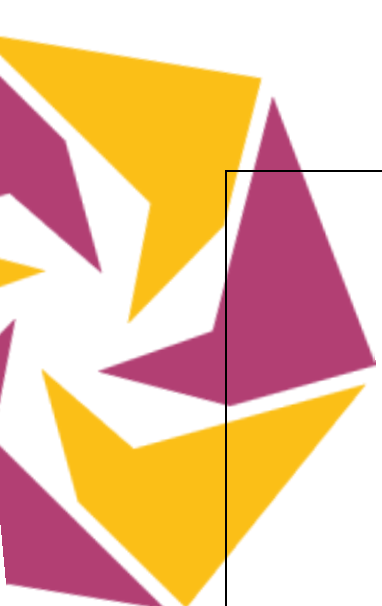
Analytical methods:[98]


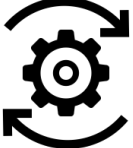
To fully exploit this potential, it is recommended to constantly improve and update existing analytical methods and tools. Furthermore, their development and use (e.g. data mining, living laboratories, and rich open data repositories) should be facilitated while keeping in mind the practical use of Big Data.

Necessary activities (in or for the public sector)




 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>One roadblocks to the general use of big data in healthcare is the technical expertise required to use it.[102]</p> <p>The value for big data in healthcare today is largely limited to research because using big data requires a very specialized skill set. Hospital IT experts familiar with SQL programming languages and traditional relational databases aren't prepared for the steep learning curve and other complexities surrounding big data.[102]</p> <p>In fact, most organizations need data scientists to manipulate and get data out of a big data environment. These experts are hard to come by and expensive and only research institutions usually have access to them. Data scientists are in huge demand across industries like banking and internet companies with deep</p>
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		<p>pockets.[102]</p> <p>A report of DG Health recommends that the digital health literacy of healthcare professionals and allied health professionals (e.g., managers) should be increased through information and education. To achieve this, existing training and education programmes for public health or healthcare should integrate data handling in the curricula to ensure the development of the necessary skills and competencies.[98]</p>
 <p>Advanced or adapted infrastructure needed or ICT</p>	<p>Open task</p>	<p>Data storage is a critical cost, security, and performance issue for the IT department. As the volume of healthcare data grows exponentially, some providers are no longer able to manage the costs and impacts of on premise data centres.[103]</p> <p>Data continue to increase at an exponential rate and the need for cross-border exchange of biomedical and healthcare data, cloud-storage, and cloud-computing is inevitable. Until many issues of data safety and security are solved, however, local solutions will be favoured.[104]</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>Healthcare organizations that want to become data driven have to make several changes to their internal processes: they must commit to valuing data as a strategic asset, making data part of their culture, developing an understanding of the complete flow of data and acting upon data-driven insights.</p> <p>These organizations need to encourage and reward the sharing of data and insights, have management and executive teams who champion transformation and build programs to develop data and analytics skills across their enterprises. Progressing across the analytics continuum toward being a data-driven organization involves a shift in the type of technologies and systems involved in working with the data, as well as an evolution in the types of business questions being asked.[105]</p>






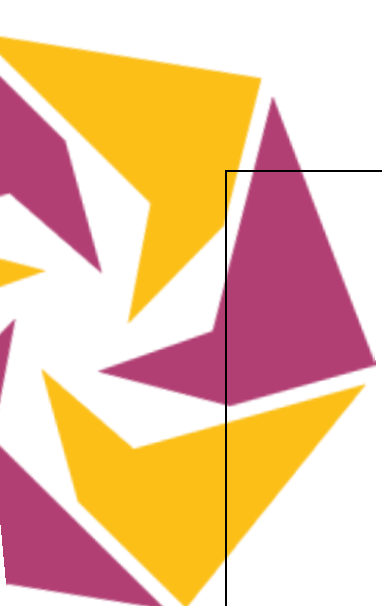
 <p>Promotion / of information / of stakeholders necessary</p>	<p>Open task</p>	<p>Traditionally, the healthcare industry has lagged behind other industries in the use of big data. Part of the problem stems from resistance to change—providers are accustomed to making treatment decisions independently, using their own clinical judgment, rather than relying on protocols based on big data.[92]</p> <p>The report of the Directorate-General for Health and Food Safety recommends to raise awareness of the practical use of Big Data in Health and its benefits to make it more tangible and understandable for the public and concerned citizens. It is therefore necessary to encourage a positive public mind set towards Big Data in Health by strengthening both the dialogue between the stakeholders in the field and the fact-based information towards the European citizens and patients.[98]</p>
 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>One roadblocks to the general use of big data in healthcare is a lack of robust, integrated security surrounding it.[102]</p> <p>In healthcare, HIPAA (Health Insurance Portability and Accountability Act) compliance is non-negotiable. Nothing is more important than the privacy and security of patient data. Although security is coming along, it has been an afterthought up to this point. But when opening up access to a large, diverse group of users, security cannot be an afterthought.[102]</p> <p>Cyber thieves routinely target medical records, and reportedly earn more money from stolen health data than by pilfering credit card details. In February, the largest ever healthcare-related data theft took place, when hackers stole records relating to 80 million patients from Anthem, the second largest US health insurer.[97]</p>
 <p>New or modified legislative framework or</p>	<p>Open task</p>	<p>A new General Data Protection Regulation (GDPR), replacing the previous Data Protection Directive (1995), was adopted in April 2016 and aims at harmonising legislation across EU Member States. As a “regulation” the GDPR will apply to all Member States without the need of transposition into national legislation. The</p>


<p>regulations necessary</p>		<p>GDPR will be implemented by mid-2018 to allow public and private sector to adapt their organisational measures to the new legal framework.[101]</p> <p>On EU-level, the implementation of national governance mechanisms for Big Data in Health can be supported by giving guidance on the process of data access approval and the technical implementation of data platforms, e.g. by providing information on models of good practice for good data governance at research level such as the International Human Epigenome Consortium (IHEC). [98]</p>
 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>By setting common standards across the Big Data value chain in Health, pooling, exchanging and analysing data will become more efficient. It is therefore recommended to adopt, or to develop where non-existent, standards with global scope addressing the issues of interoperability (cf. ICT Standardisation Priorities for the Digital Single Market) e.g. in areas related to patient consent in the use of Big Data in Health or nomenclature of genotyping or ethics to name only a few.[98]</p>
 <p>Need for a more economical solution</p>	<p>Open task</p>	<p>Due to its unstructured nature and open source roots, big data is much less expensive to own and operate than a traditional relational database.[102]</p> <p>However, other important economic factors are related to data storage and personnel costs.</p>
 <p>Ethical issues</p>	<p>Open task</p>	<p>Ethical issues mainly refer to privacy and data protection.</p> <p>A lot of scepticism with regards to “where the data goes to”, “by whom it is used” and “for what purpose” is present in most public opinion and, so far, European and international fragmented approaches together with an overly complex legal environment did not help.[101]</p>
 <p>Societal issues</p>		<p>No societal issues identified.</p>

 Health issues		No health issues identified (apart from the expected positive impact on the health of the citizens)
 Public acceptance	Open task	People have specific expectations of confidentiality where their health data is concerned. They believe that when big data is used in the context of health data, these expectations are ignored or not sufficiently taken into account.[106]




Roadmap for biometrics


Description and state of the art	
 <p>Definition</p>	<p><i>Biometrics</i> as a characteristic is a measurable biological and behavioural characteristic that can be used for automated recognition and as a process it encompasses automated methods of recognizing an individual based on measurable biological and behavioural characteristics[107]. Biometric identifiers are often categorized as physiological and behavioural characteristics, where the former are related to the shape of the body (fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina, odour/scent, etc.), while the latter are related to the pattern of behaviour of a person (e.g. typing rhythm, gait, voice, etc.).</p> <p>Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control[108]. Biometric authentication methods use biometric characteristics or traits to verify users' claimed identities when users access endpoint devices, networks, networked applications or Web applications[109].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Faster and transparent access to public sector services</p>
 <p>Existing solutions /applications /services</p>	<p>Biometrics has found several application in the public sector, e.g. in border control, visa programs as well as in government and law enforcement agencies, for example:</p> <ul style="list-style-type: none"> • Automated e-Passport gates -- self-service kiosks that verify a traveller's identity with biometric recognition software[110] • the Australian Tax Office (ATO) is an example of a leading public sector organisation that has already embraced voice biometric technology[111] • In Belgium, citizens use their ID cards to manage their social security, request car licence plates and conduct their tax declarations over the internet. [112] <p><i>Biometric visa program:</i> With the exception of France, which had already implemented biometrics in its visa program, the European Union and Schengen Treaty countries began rolling out their biometric</p>

















	<p>(fingerprint and digital photograph) visa program in October 2011.</p> <p><i>Biometric identity cards (e.g.):</i></p> <p>Bulgaria began issuing biometric identity cards (mandatory for all citizens) in March 2010. Bulgaria also issues biometric passports and driver’s licenses containing embedded biometric data.[113]</p> <p>Finland introduced biometric residence permit cards in 2012. The cards include a chip that stores a digital photograph and two fingerprints.[113]</p> <p>France has issued only biometric passports since 2009. The passport requires the collection of a biometric digital photo and eight fingerprints.[113]</p> <p>In May 2005 the German Parliament already approved the implementation of the ePass. The ePass has been in circulation since November 2005, and contains a chip that holds a digital photograph and one fingerprint from each hand.[114]</p> <p>In accordance with EU standards Luxembourg issues biometric passports with a chip containing a digital photograph, two fingerprints and an image of the holder’s signature.[113]</p> <p>Since 2009 the Netherlands has issued biometric passports containing an embedded chip with a digital photograph and fingerprints. Although only two fingerprints are stored on the passport’s chip, four fingerprints are taken and stored by the local government in a central database that is also used to pursue criminal investigations.[113]</p> <p>In India, the government-led national identity program Aadhaar aims to establish a biometrics-based registry for all 1.2 billion of its residents. After having their identity verified, registrants receive a unique 12-digit ID number that allows them to access a range of government and private sector services. Aadhaar is the most ambitious government-led biometrics program in the world, with over 900 million Indian residents already enrolled.[110]</p>
 <p>Main actors regarding R&D of this</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V • Morpho • Katholieke Universiteit Leuven • Centre National de la Recherche Scientifique

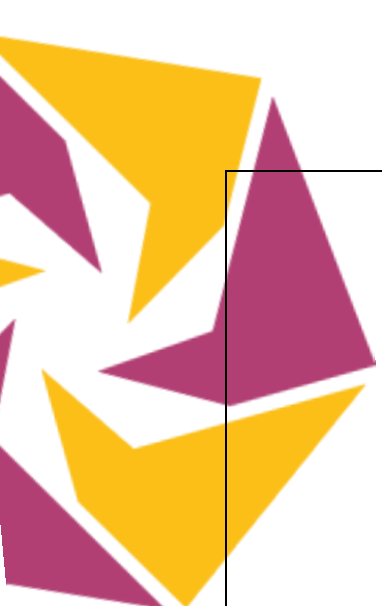







<p>technology</p>  <p>Current research activities</p>	<p>FP7-projects: 4DVIDEO, ACTIBIO, ADABTS, ADDPRIV, AMASS, ANASID, BBFOR2, BIO, CAPER, CLOVISEN, COPRA, CRESCENDO, DEMASST, DETECTOR, DIGIDEAS, DIGITAL.ME, EFFISEC, EGAIS, EIW3R, ELSAIDTCGT, ETHICAL, ETHICSWEB, ETICA, EU, EUCONRES, EUCRIMINALSECURITY, EURECNET, EUSECON, GEST, GINI, HBP, HIDE, ICTETHICS, IDETECT4ALL, IMSK, INDECT, INEX, LAST, MOBIO, MOSAIC, MUSIS, MUTIVIS, NORDIA, OPERAMAR, PASS, PATS, PERSEUS, PHM, PHM, PRACTIS, PRESCIENT, PRIMELIFE, PRISM, PROMETHEUS, RISE, RTD, SAMURAI, SAPIENT, SEARISE, SECTRONIC, SENIOR, , SEPIA, SEREN, SFLY, SMART, SMARTENC, SNAPS, SUBITO, TABULARASA, TACO, TALOS, TASS, TECHNOLIFE, TERATOP, TURBINE, VANAHEIM, VIDEOSENSE, VISION, VPH</p> <p>Other EU-projects: AMBER (mobile biometrics), PROTECT (automated border control), SpeechXRays (speech biometrics), BEAT(evaluation and testing), BIO-DISTANCE (biometrics at distance), BIO-RESIDENCE (access), BIOHEALTH (eHealth)</p> <p>BMBF:[3, 108] GES-3D, MARS, MisPel, FeGeb[109], CRISP, IP2 Projekt[110]</p> <p>BSI:[111] BioFace, BioFinger, BioP, BioKeyS, NFIQ2[112]</p> <p>EUROSTARS projects: MOBITOUCH-ID[113], BioSec[114], BioSpeak[115], BIRDS [116], ASSURE-ID[117]</p>
 <p>Impact assessment</p>	<p>Public Sector Modernization:</p> <ul style="list-style-type: none"> • Efficiency / Productivity • Sustainability • Cross-organization cooperation • Quality of Services provided • Transparency • And negative impact on “creation of trust and confidence” <p>Public Sector as Innovation Driver:</p> <ul style="list-style-type: none"> • Public Safety • Transport Infrastructure • e-security • and negative impact on equity and inclusiveness as well as on privacy and security
Necessary technological modifications	
 <p>Potential use</p>	<ul style="list-style-type: none"> • Physical access control • Computer log-in • Welfare disbursement • International border crossing / Border management / Speed mobility in borders • Airport kiosks for checking passports

cases	<ul style="list-style-type: none"> • Driver's license • Facial recognition to speed up processes and manage queues • Identify criminals on the fly • Avoid fraud on competitive examinations • Life identification against watch lists (terrorism)
 <p>Technological challenges</p>	<p>Most of the research in biometric recognition has focused on the following two fundamental problems:[115]</p> <ul style="list-style-type: none"> • The challenge of identifying the best feature representation scheme for a given biometric trait (e.g. fingerprint, face and iris). The desired set of features should retain all the discriminative information that is distinctive to a person and remain invariant to intra-subject variations. • The challenge of designing a robust matcher (e.g. face or fingerprint matcher) for a given representation scheme. The desired matching algorithm must model the variations in the features belonging to the same individual, while accounting for variations between features of different individuals. <p>The unsolved problems in biometric recognition can be divided into two categories: (i) problems that involve fundamental issues related to design of recognition systems and (ii) problems that are specific to applications that will use biometric recognition.[115]</p> <p>Feature extraction and matching schemes that can handle poor quality biometric samples (e.g. face images from a surveillance video or latent fingerprint images) need to further developed. In the case of application-specific problems, the two main unresolved issues are (i) techniques to shield a biometric system from adversarial attacks/threats and provide assurances on user privacy, and (ii) techniques to assess usability of a biometric system and estimate the return on investment. Other unresolved challenges are: [115]</p> <ul style="list-style-type: none"> • Distinctiveness of biometric traits (estimating the individuality of a biometric trait) • Persistence of biometric traits (Persistence of a biometric trait is related to the notion of aging. Aging refers to changes in a biometric trait or the corresponding template over a time span, which can potentially impact the accuracy of a biometric system) • Unconstrained biometric sensing environment (There are some person recognition applications where it is very difficult to impose constraints on how the biometric trait should be acquired. One example is latent fingerprints acquired from crime scenes.) • System security and user privacy (the biometric

		system may be vulnerable to a number of security threats, which may eventually affect the security of the end application)
Necessary activities (in or for the public sector)		
 Development of a specific training necessary		For the actual usage of biometric identity systems no training is needed. The selection and implementation of these systems has to be done by experts.
 Advanced or adapted ICT infrastructure needed	Open task	Yes, specific hardware like a sensor, biometric processor and template storage is needed.
 Change of (public sector internal) processes necessary	Open task	Yes, the public sector processes (like authorization processes to online services) have to be adapted to the usage of biometric identity systems.
 Promotion of information / of stakeholders necessary		No issues identified in this area.
 Need to deal with cyber security issues	Open task	Recent "breaches of security", including the Snowden incident, have made the public increasingly sceptical about who has access to their biometric data and whether it is stored securely. Research Councils UK stated that establishing public confidence in "the storage and access arrangements around their biometric data" was key to ensuring greater public acceptance of biometrics[116]
 New or modified		There are a number of data protection issues associated with the storage of personal (biometric) data. In particular, the ensured accuracy, security, control and proportionality of that storage are especially important.[117]




<p>legislative framework or regulations necessary</p>		<p>However, on May 25, 2016 the EU Data Protection Regulation came into force. The new legislation, which was several years in the making, encompasses all recent technological developments including biometrics.[118]</p>
 <p>Development of a common standard necessary</p>		<p>Several national and international players are developing biometric standards. They include the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and ITU's Telecommunication Standardization Sector (ITU-T). Industry consortia also develop standards that support the objectives of their membership, while United Nations specialized agencies, such as the International Civil Aviation Organization (ICAO) and the International Labour Organization (ILO), develop standards within their specific domains that might not have been addressed by other organizations. In particular, ICAO is responsible for the standardization of machine-readable travel documents, including electronic passports, while ILO has provided guidelines on biometric identity documents for seafarers.[119]</p>
 <p>Need for a more economical solution</p>		<p>This depends on the specific application and the country, e.g. the national biometric passports vary in their price depending on the country of origin.</p>
 <p>Ethical issues</p>	<p>Open task</p>	<p>The application of biometric data and technologies raises ethical and legal questions related to privacy, autonomy, informed consent, confidentiality and liberty.[116]</p> <p>By turning the human subject into a collection of biometric parameters, biometrics could dehumanize the person,[120] infringe bodily integrity, and, ultimately, offend human dignity.[121]</p> <p>There are three categories of privacy concerns:[122]</p> <ul style="list-style-type: none"> • Unintended functional scope: The authentication goes further than



		<p>authentication.</p> <ul style="list-style-type: none"> • Unintended application scope: The authentication process correctly identifies the subject when the subject did not wish to be identified. • Covert identification: The subject is identified without seeking identification or authentication, i.e. a subject's face is identified in a crowd. <p>One of the major concerns aired by opponents of biometrics technologies is that they pose a threat to individual privacy. But advocates argue the opposite, that biometrics can be used to safeguard citizens against data breaches, identity theft, fraud and other violations of personal rights.[110]</p>
 Societal issues		No societal issues identified.
 Health issues		No health issues identified.
 Public acceptance	<p>Open task</p>	<p>According to Sir John Adye, Identity Assurance Systems, public distrust of biometrics remained “prevalent in countries like the UK” while Professor van Zoonen, IMPRINTS, identified biometrics as “the most controversial and worrying of all means of authentication” among the British public[116]</p>



Roadmap for block chain technology

Description and state of the art	
 Definition	<p>Blockchain is a peer to peer software technology that protects the integrity of a digital piece of information.[123] It is a type of distributed ledger or database in which value exchange transactions (in bitcoin or other token) are sequentially grouped into blocks. Each block contains a timestamp and is chained to the previous block and immutably recorded across a peer-to-peer network, using cryptographic trust and assurance mechanisms.[124] The data in a block cannot be altered retrospectively.</p> <p>Though originally invented to create the alternative currency titled "Bitcoin", blockchain may be used for other cryptocurrencies as well, as the digital ledger underpinning them[125]. In fact, not only information, but anything of value - money, titles, signatures, deeds, music, art, scientific discoveries, intellectual property, and even votes - can be moved and stored securely and privately.</p>
 Addressed societal /business or public sector need	<p>Societal need:</p> <p>Faster and transparent access to public sector services</p>
 Existing solutions /applications /services	<p>Estonia:[126][127]</p> <ul style="list-style-type: none"> • <i>E-residency-</i> It is a first-of-a-kind transnational digital identity. E-residents can digitally sign documents and contracts, verify the authenticity of signed documents, encrypt and transmit documents securely, access online payment service providers and declare Estonian taxes online. The immutability of Blockchain ensures that the data cannot be manipulated and engenders trust. • <i>E-health-</i> In Estonia's e-health system, integrity of medical documents is ensured by a Blockchain technology. • <i>Shareholder voting-</i> In February, a pilot project was initiated to allow shareholders of companies listed on Nasdaq's Tallinn Stock Exchange to vote digitally in shareholder meetings. Shareholders are authenticated via e-residency, while Nasdaq's blockchain-enabled platform records the votes quickly and securely. <p>Hong Kong:[126]</p> <ul style="list-style-type: none"> • <i>Property valuations-</i> A Distributed Ledger Technology prototype for carrying out property valuations for use in



the mortgage loan was being tested.

Sweden:[126][128]

- *Land registry*- The Swedish Land Registry had started tests to put the country's land registry system on Blockchain.

UK:[126]

- *Monitoring research grants*- Plans were announced to use Blockchain to improve the efficiency of taxpayer money distributed as grants to agencies and partners for research and innovation.
- *Blockchain as a Service (BaaS)*- A platform for deploying and managing blockchain applications and services was made available to the UK public sector. It is meant for the agencies to develop DLT based proofs-of-concept and large scale identity use cases.

Several countries including **Ghana, Kenya and Nigeria** have begun to use blockchains to manage land registries. Their aim is to create a clear and trustworthy record of ownership, in response to problems with registration, corruption and poor levels of public access to records.

Dubai wants distributed ledgers to power its entire government by 2020.[129]




Georgia's National Agency of Public Registry has recently moved its land registry onto the blockchain.[129]

Earlier this year, software firms Epigraph and Factom announced a partnership on a project that attempts to reduce fraud within the **Honduran** government. The project's focus is on public land registries.[130]



The **Isle of Man** is currently working on government initiatives to store information and make contracts using blockchain applications. One of the initial projects involves the Department of Economic Development in the Crown dependency using a blockchain registry as a record of which companies on the Isle of Man actively use cryptocurrencies. [131]







In **Singapore**, the government is looking to blockchain to stop traders from defrauding banks. Fraudulent companies used duplicate invoices for the same goods to obtain millions of dollars from banks. This has led the Singapore government to develop a system with local banks focused on preventing invoice fraud by using blockchain to create a unique cryptographic hash (a unique fingerprint) for every invoice.[131]









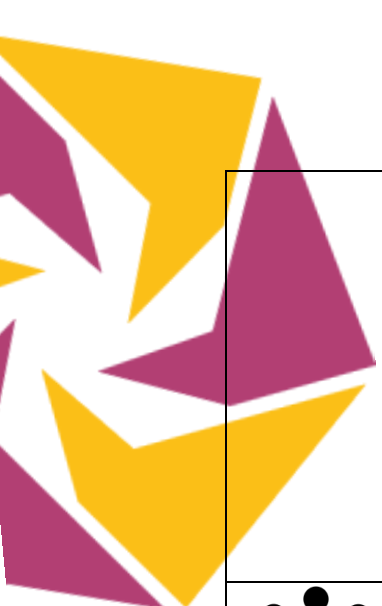
	<p>In August, Australia Post presented a plan to the Victorian Electoral Matters Committee to use Blockchain for voting.[126]</p> <p>There is a blockchain-as-a-service offering available to public sector organisations through the GDS Digital Marketplace on G-Cloud 8. The platform is offered by Credits, a startup formed in 2014. Capgemini also has a public sector blockchain consultancy offer on G-Cloud. These services together offer a range of blockchain services to UK public sector bodies including health, local government and education.[131]</p>
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Centre National de la Recherche Scientifique • Forum Virium Helsinki Oy • Fundacio Barcelona Media • Fundacio per a la Universitat Oberta de Catalunya • Geie Ercim • Immi Alþjóðleg Stofnun Um Upplýsinga- Og Tjaningarfrelsi Immi International Modern Media Institute • Neo Innovation Europe Ltd • Nesta Lbg • Open Knowledge Foundation Lbg • Stichting Dyne. Org
 <p>Current research activities</p>	<p>EU-projects:</p> <p>MH-MD, DECODE, D-CENT</p> <p>EUROSTARS project T-CAB[118]</p> <p>Other projects:</p> <p>CollCo [119]</p> <p>Intellisys Capital[120]</p>
 <p>Impact assessment</p>	<p>Public Sector Modernization:</p> <ul style="list-style-type: none"> • Efficiency / Productivity • Quality of Services provided • Image Modernization • Transparency • Creation of Trust & Confidence <p>Public Sector as Innovation Driver:</p> <ul style="list-style-type: none"> • Innovation • Privacy & Security • Public Safety • e-security • Energy Consumption / Natural Resources Utilization







Necessary technological modifications

 <p>Potential cases</p>	<p>use</p> <ul style="list-style-type: none"> • Vehicle registries • Storing citizens' identities - personal details/data • Voting records (Electronic voting) • Property/Land record registry. • Use in Resident Registration Offices • Collecting taxes • Management of property titles and monitoring/regulating transactions among citizens and enterprises. • Smart contracts (self-executing contractual states, stored on the blockchain, which nobody controls and therefore everyone can trust)
 <p>Technological challenges</p>	<p>This technology is still in its infancy and its potential and true scope of application will only be understood in the next 2-3 years. However, some of the potential uses are already apparent today. Already central banks and financial regulatory authorities are exploring how their can use this new technology.[132]</p> <p>Thus, the primary challenge to adoption is that blockchain is still a nascent technology, sot that there are unknown factors or vulnerabilities.[133]</p> <p>At the moment, the embedded risks are poorly understood, and most likely they relate to the risks that operate in virtual world, such as external hacking, corruption and loss of data. Although encryption provides a solution of superior safety, it is naïve to assume it guarantees an absolute protection of data against cyber-attacks.[132]</p> <p>Critical concerns regarding blockchain technology address privacy and confidentiality, which have to be balanced with transparency.[132]</p> <p>Resolving challenges such as transaction speed, the verification process, and data limits will also be crucial in making blockchain widely applicable.[134]</p> <p>UK Government Chief Scientific Adviser recommends that the UK research community should invest in the research required to ensure that distributed ledgers are scalable, secure and provide proof of correctness of their contents. They need to provide high-performance, low-latency operations, appropriate to the domain within which the technology is being deployed. They need to be energy efficient. The private sector should support the pre-competitive research that will ultimately facilitate new commercial applications that are robust and secure. This includes work on obvious areas such as cryptography and cybersecurity but also extends to the development of new</p>

		types of algorithm.[135]
Necessary activities (in or for the public sector)		
 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>Currently there are only few blockchain experts. [136]</p> <p>Thus it will be a challenge for the public sector to recruit personnel with experience in blockchain technology.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>Blockchain as a service (BaaS) lets companies experiment with distributed ledger technology in the cloud. By eliminating the need for a large upfront capital investment, BaaS is perhaps the easiest, lowest-risk gateway to enterprise blockchain adoption.[137] There is a blockchain-as-a-service offering available to public sector organisations through the GDS Digital Marketplace on G-Cloud.[136]</p> <p>The public sector organization has to decide which infrastructure it will use (e.g. cloud-based services).</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>A blockchain represents a total shift away from the traditional ways of doing things. It places trust and authority in a decentralised network rather than in a powerful central institution. And for most, this loss of control can be deeply unsettling. It has been estimated that a blockchain is about 80 per cent business process change and 20 per cent technology implementation.[138] In order to make the switch, companies must strategize the transition.[134]</p>
 <p>Promotion of information / stakeholders necessary</p>		<p>According to a recent IBM survey of government leaders, nine in ten government organisations say they plan to invest in blockchain technology to help manage financial transactions, assets, contracts and regulatory compliance by next year.[129] Consequently, monetary authorities of several countries, from China to the US are looking at how to regulate its use.[126]</p>
 <p>Need to deal with cyber security</p>	<p>Open task</p>	<p>While solutions exist, including private or permissioned blockchains and strong encryption, there are still cyber security concerns that need to be addressed before the general public will entrust their personal data to a blockchain solution.[134]</p>




<p>issues</p>		<p>Current issues are e.g. Sybil-attacks and distributed denial of service attacks.^[136]</p>
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>According to Capgemini governments have to get prepared for blockchain technology and develop legislative frameworks or regulations.^[136]</p> <p>They could consider how blockchain might help them improve public services, particularly in providing transparency and accountability, and whether they should recognise independent 'state-like' services within their jurisdictions.</p> <p>End-to-end encryption may be also considered in the upcoming review of the EU's ePrivacy Directive.^[128]</p>
 <p>Development of a common standard necessary</p>		<p>In April 2016, Standards Australia submitted a proposal for developing new international standards on blockchain technology and electronic distributed ledger technologies. The proposal was considered by the 161 member countries of International Organization for Standardization (ISO) and approved in September.^[126]</p>
 <p>Need for a more economical solution</p>		<p>By eliminating third party intermediaries and overhead costs for exchanging assets, blockchains have the potential to greatly reduce transaction fees.^[134]</p> <p>A public record also makes audits redundant.^[130]</p> <p>As another benefit it reduces fraud and error in payments.^[139]</p> <p>Blockchain offers tremendous savings in transaction costs and time, but the high initial capital costs could be a deterrent.^[134]</p> <p>Another issue is that the Bitcoin blockchain network's miners are attempting 450 thousand trillion solutions per second in efforts to validate transactions, using substantial amounts of computer power.^[134]</p>
 <p>Ethical issues</p>	<p>Open task</p>	<p>It is possible (albeit only sometimes and with substantial effort), to identify the individuals associated with transactions like e.g. bank transfers or other sensitive data. This could compromise their privacy and anonymity. While some blockchains do offer full anonymity,</p>

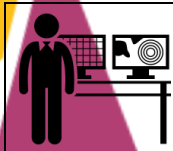


		<p>some sensitive information simply should not be distributed in this way.[128]</p> <p>The fact that data in the blockchain is immutable provides transparency and accountability. However, it may also compromise privacy and data protection. This immutability may compromise the 'right to be forgotten', whereby users may, under certain circumstances, demand that their personal data be erased.[128]</p>
 Societal issues		<p>It is important to ensure that all citizens are able to access their public services. There is a risk that blockchain could exacerbate the existing digital divide. Citizens who are unable to use internet services for whatever reason may not be able to take full and direct advantage of the blockchain developments that would give them more control over their data and transactions[128]</p>
 Health issues		<p>No health issues identified.</p>
 Public acceptance		<p>According to a recent IBM survey of government leaders, nine in ten government organisations say they plan to invest in blockchain technology to help manage financial transactions, assets, contracts and regulatory compliance by next year.[129]</p>



Roadmap for cloud computing

Description and state of the art	
 <p>Definition</p>	<p><i>Cloud Computing</i> is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies[140]. It refers to the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. It is a type of internet-based computing and a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services) which can be rapidly provisioned and released with minimal management effort.</p> <p>Cloud Computing and storage solutions provide users and enterprises with various capabilities to store and process their data in third-party data centers that may be located far from the user – ranging from across a city to across the world. Cloud computing relies on sharing of resources to achieve coherence and economy of scale, similar to a utility (like the electricity grid) over an electricity network. It provides users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers[141].</p> <p>In a cloud computing environment, end users can choose their devices, applications and services, synchronize content and application state across multiple devices and address application portability across devices[142].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Faster and transparent access to PS services</p>
 <p>Existing solutions /applications /services</p>	<ul style="list-style-type: none"> • Public clouds (Google docs, Microsoft Office 365, SAP Business by Design) • Private Cloud of companies • Hybrid Clouds (has elements of private and public cloud) [143] • Infrastructure as a service (IaaS) (e.g. Amazon Web Services, Google Compute Engine, Windows Azure)[144] • Platform as a service (PaaS) (e.g. Google App Engine, Amazon Elastic Beanstalk)[145] • Software-as-a-Service (SaaS) (e.g. from Microsoft, Google, Salesforce.com, Cisco, Intuit)[146]



Main actors regarding R&D of this technology

- Atos Spain SA
- Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V.
- Institut National de Recherche en Informatique et en Automatique
- Centre National de la Recherche Scientifique
- Commissariat a l’Energie Atomique et aux Energies Alternatives
- Engineering - Ingegneria Informatica Spa



Current research activities

EU R&D projects and programmes[147]
 SPOTLIGHT (radio access technologies), HOLA CLOUD (EU roadmap), SECCRIT (for critical infrastructures), MONICA (mobile cloud computing), TRESCCA (secure cloud computing), MOBILECLOUD (linking sino-European research institutions) WELCOME (medical domain), CLOUDCATALYST (for EU economy), HARNESS (software systems) EUBrazilOpenBio (biodiversity), CloudScale (scalability), Cloud-TM (programming module), ICE Wish (energy and wastage reduction), CleanSky (network), DependableCloud (dependability), SOLAS (scalability)

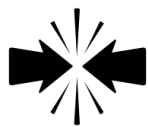
Other national or international R&D projects and programmes

BMBF: Cloud Computing[56]

BMW:

Sealed Cloud, Value4Cloud, Cloud4E, GGC-Lab ,eBusiness Lotse Schwaben, MimoSecco ;
 CDTI (Spain): cloud-application for taxi drivers[148]

Other resources (R&D programmes, policy papers, etc.)
 The European Cloud initiative[149] [150]







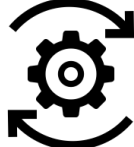

Impact assessment







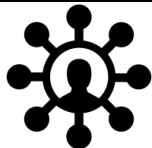
Public Sector Modernisation




- Degree of Resources (Capital, Personnel, Infrastructure) Utilization
- Efficiency / Productivity
- Sustainability
- Cross-organization Cooperation
- Quality of Services Provided
- Transparency

Public Sector as an Innovation Driver





- Productivity (Labor / Capital / Resource) & Growth
- Innovation
- ICT Infrastructure
- e-Security
- Energy Consumption – Natural Resources Utilization








 Potential use cases	<ul style="list-style-type: none"> • Share ICT resources among multiple agencies • Collaboration applications (e-mail, web conferencing) • Cloud bursting for increased availability at peak seasons (e.g. final exams' results, etc.)
 Technological challenges	<ul style="list-style-type: none"> • Absence of legislative framework regarding cloud services • Loss of control over sensitive data • Non strict SLAs
Necessary technological modifications	
 Development of a specific training necessary	<p style="text-align: center;">Open task</p> <p>Some experts pointed out that certain staff members (e.g. the elderly) will need assistance to adapt to new technologies in general. Generally, the skill infrastructure in the public sector is described by one expert as insufficient to make full use of cloud computing and other technologies. However, one study regarding Korea contradicts this, but this might result from a generally more tech-savvy culture[151].</p>
 Advanced or adapted ICT infrastructure needed	<p style="text-align: center; font-size: 2em;">?</p> <p>One expert highlighted the fact that the public sector mostly does not have an appropriate infrastructure in place. However, certain literature suggests otherwise[152].</p>
 Change of (public sector internal) processes necessary	<p style="text-align: center;">Open task</p> <p>One expert describes the need for a generational change within the public sector, meaning the need for the public sector to fully embrace new technologies and incorporate them in their internal processes (also mentioned here[153]).</p> <p>Also, roles and processes within organisation will need to be adapted to the new technologies[152].</p> <p>Public sector organisations will need to develop their own standards and procedures, e.g. for information risk assessment or data management[151, 152].</p>
 Promotion /	<p style="text-align: center;">Open task</p> <p>Citizens and public servants will need to be informed thoroughly on reliability, security and availability of cloud services[151].</p>









information of stakeholders necessary		
 Need to deal with cyber security issues	Open task	<p>Adoption of cloud computing will pose cyber security challenges, as one expert mentioned for example the access of hackers to stored data.</p> <p>Achieving high security standards and tackling (perceived) security issues is also important to raise public acceptance[151, 154]</p>
 New or modified legislative framework or regulations necessary	Open task	<p>A legal framework surrounding the use of Cloud Computing will help addressing change resistance. It should be flexible enough to deal with future challenges.</p> <p>The fact that data in the cloud is potentially stored outside of national borders poses another legislative challenge that needs to be addressed[152, 154].</p>
 Development of a common standard necessary	Open task	<p>Development of a common standard can ease migrating data and applications from one service provider to another. However, this responsibility rests mainly with the service providers[154]</p>
 Need for a more economical solution	Open task	<p>Businesses need be to be incentivised to create appropriate cloud solutions for the public sector[151].</p>
Dealing with other challenges		
 Ethical issues		No ethical issues were identified.
 Societal issues	Open task	<p>Data protection is an important factor, any cloud solutions should cater to present norms instead of trying to achieve norm change.</p>









 Health issues		No health issues were identified.
 Public acceptance	Open task	Can be hampered if no legal framework exists. Public acceptance also hinges on familiarity of the public with and maturity of cloud technology[151].

Roadmap for e-identities (and e-signatures)





Description and state of the art	
 Definition	<p>An <i>e-Identity</i> or <i>Electronic Identity</i> is a means for people to prove electronically that they are who they say they are and thus gain access to benefits or services provided by government authorities, banks or other companies[155].</p> <p>One form of Electronic Identification (eID) is an electronic identification card (eIC), which is a physical identity card that can be used for online and offline personal identification or authentication. The eIC is a smartcard in ID-1 format of a regular bank card, with identity information printed on the surface (such as personal details and a photograph) and in an embedded RFID microchip, similar to that in biometric passports. The chip stores the information printed on the card (such as the holder's name and date of birth) and the holder's biometric photo. It may also store the holder's fingerprints. The card may be used for online authentication, such as for age verification or for e-government applications. An electronic signature, provided by a private company, may also be stored on the chip. Apart from online authentication, an eIC may also provide users the option to sign electronic documents with a digital signature (e-signature)[156].</p>
 Addressed societal /business or public sector need	<p>Societal Need:</p> <p>Digitization</p>
 Existing solutions /applications /services	<p>Electronic identity cards in many European Countries (e.g. in Estonia for logging into bank accounts, as pre-paid public transport ticket, for digital signatures, for i-voting, for assessing government databases to check medical records, taxes, for picking up e-prescriptions)[157]</p>
 Main actors regarding R&D of this technology	<ul style="list-style-type: none"> • IBM Research Gmbh • University of Birmingham • Universität Stuttgart • Aalborg Universitet • Danmarks Tekniske Universitet • Katholieke Universiteit Leuven • Norsk Regnesentral Stiftelse • Technische Universitaet Darmstadt • Technische Universiteit Eindhoven





 <p>Current research activities</p>	<ul style="list-style-type: none"> • University Of Cambridge <p>ABC4Trust, ELUTE, FutureID, GUIDE, HIGHTRUSTWALLET, HYDRA, ICONN, NeMeCo, NOVEL TRANSALDOLASES, PERCY, SENSE, SWIFT, TURBINE, VADER, VAMPIRE, VIRTUALVIALS</p>	
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Degree of Resources (Capital, Personnel, Infrastructure Utilization) • Efficiency/productivity • Cross-organization cooperation • Quality of services provided <p>Public sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Equity & Inclusiveness • Privacy & Security • ICT Infrastructure • e-Security 	
Necessary activities (in or for the public sector)		
 <p>Potential cases use</p>	<ul style="list-style-type: none"> • e-Identities for citizens (also for refugees and migrants) • Pan-European electronic-identity authentication system • Use digital IDs in European processes 	
 <p>Technological challenges</p>	<ul style="list-style-type: none"> • Interoperability challenges (multiple identity schemes applied on a per-sector/per-country basis – multitude of standards used and lack of a commonly accepted one. 	
Necessary activities (in or for the public sector)		
 <p>Development of a specific training necessary</p>		<p>For the actual usage of e-identity systems no training is needed. The selection and implementation of these systems has to be done by experts.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>The public organizations need the e-ID infrastructure itself and also e.g. the cards for the citizens.</p>

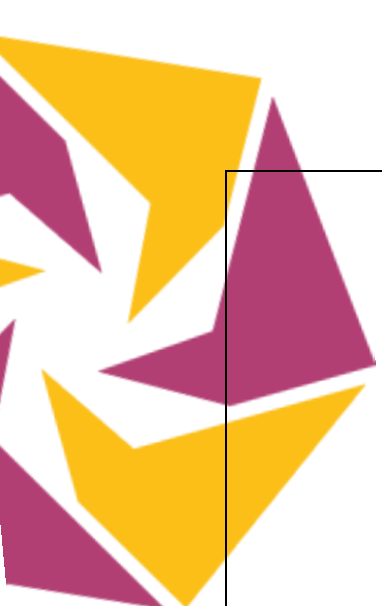
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>Yes, the public sector processes (like authorization processes to online services) have to be adapted to the usage of e-identity systems.</p>
 <p>Promotion / information of stakeholders necessary</p>		<p>No promotion/information of stakeholders necessary.</p>
 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>Security is also a matter of concern. Data breaches are on the rise as with e-identity systems more activities move online.[158]</p> <p>Current data protection systems might not be appropriate to face increasingly sophisticated techniques to steal data and identities in the electronic world.[158]</p> <p>However, the Regulation (EU) N°910/2014 on electronic identification and trust services for electronic transactions in the internal market (eIDAS Regulation) adopted by the co-legislators on 23 July 2014 provides a regulatory environment to enable secure and seamless electronic interactions between businesses, citizens and public authorities.[159]</p>
 <p>New or modified legislative framework or regulations necessary</p>		<p>In many European countries e-identity systems are already up and running.</p> <p>The European Union has published and implemented the eIDAS regulation (electronic identification and trust services for electronic transactions in the internal market).[159]</p>
 <p>Development of</p>		<p>The ENISA paper discusses concrete standardisation activities associated with electronic IDs and trust service providers, providing an overview of standards developed under the mandate m460 from the European</p>

a common standard necessary		Commission and others, related to eIDAS Regulation.[160]
 Need for a more economical solution	Open task	High costs of the eID infrastructure itself and organisational costs (card issuance and cardholder enrolment).
Dealing with challenges		
 2	Open task	Civil rights groups feel threatened by a perceived invasion of their private life by public authorities due to the introduction of e-identity cards.[158]
 Societal issues		No issues identified in this area.
 Health issues		Not issues identified in this area.
 Public acceptance		Some experts thought that there will be some issues with public acceptance and at the same time other workshop participants felt that an issue with public acceptance will not be likely. Still the acceptance of the public is not naturally given and often depends on the used technology itself and also on the general trust in government and institutions in the different countries. The public also has little knowledge about the usage of electronic identities and one of the main concerns is the protection from privacy invasions and identity theft.[161]

Roadmap for internet of things (IoT)

Description and state of the art	
 Definition	<p>IoT is based on the convergence of multiple technologies, including ubiquitous wireless communication, real-time analytics, machine learning, commodity sensors, and embedded systems and the proliferation of smart devices.</p> <p>IoT stands for the internetworking of physical devices, vehicles (also referred to as “connected devices” or “smart devices”), buildings and other items – embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data[162]. IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities[163].</p> <p>The Internet of Things, Industrial Internet, and Internet of Everything will gradually morph into the <i>Internet of Anything (IoA)</i>. IoA envisions a common software “ecosystem” capable of accommodating any and all sensor inputs, system states, operating conditions, and data contexts – an overarching “Internet Operating System”[164].</p>
 Addressed societal /business or public sector need	<p>Societal need:</p> <p>Inclusive well-being and health</p>
 Existing solutions /applications /services	<p>There are several applications of the IoT technology in the area of Health, the latter pertaining to providing assistance to people or enabling automated medication and maintenance of medical devices[165]. According to Dimitrov, “devices and mobile apps are now increasingly used and integrated with telemedicine and telehealth via the medical Internet of Things (mIoT)”[166].</p>
 Main actors	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Commissariat a l’Energie Atomique et aux Energies Alternatives • Institut National de Recherche en Informatique et en

regarding R&D of this technology	Automatique <ul style="list-style-type: none"> • University of Surrey • Atos Spain SA
 Current research activities	Indicative R&D projects include: <ul style="list-style-type: none"> • Make it ReAAL, a project to promote standards, guidelines and open platforms for interoperable solutions in the domain of active and independent living[167]. • DoctorCloud, an innovative ICT platform in the service of elder and patients for emergencies[168]. • REMOSIS ("Remote Mosquito Situation and Identification System"), a novel smart trap station as an Internet of Things surveillance solution to remotely count and identify the species of disease-carrying mosquitoes[169, 170]
 Impact assessment	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Degree of Resources (Capital, Personnel, Infrastructure) Utilization • Efficiency / Productivity • Quality of Services Provided <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Productivity (Labour / Capital / Resource) & Growth • Employment • Quality of Health • Privacy & Security • Public Safety • Transport Infrastructure • e-Security • Quality of the Biosphere • Energy Consumption – Natural Resources Utilization • Environmental Awareness Creation
Necessary technological modifications	
 Potential use cases	Potential applications of the IoT technology in the domain of health care include: <ul style="list-style-type: none"> • Remote health monitoring • Emergency notification systems / contacting the hospital in case of emergencies • Telemedicine • Early detection of and warning about patients at risk Dimitrov expects a new category of "personalised preventative health coaches" (Digital Health Advisors)" to emerge. He expects them to help their clients avoid chronic and diet-related illness, improve cognitive function, achieve improved mental health and achieve improved lifestyles overall[166].
 Technological challenges	As for every technology, for the Internet of Things to thrive there are major technological challenges to overcome: The development of IoT networks has turned into a serious security concern, which derives from the fact that IoT devices are becoming more and more ingrained in our lives[171]. In fact security concerns are no longer limited to the protection of sensitive information and assets; even human lives and






health can become the target of IoT hack attacks, as indicated by the hacking of pace makers[172].







Connecting so many devices is another big challenge for IoT that defies the very structure of current communication models. The latter are currently relying on the centralized server/client paradigm to authenticate, authorize and connect different nodes in a network and are sufficient for current IoT systems but will turn into a bottleneck when IoT networks grow to join billion of devices, thereby calling for their decentralisation[171].








IoT is growing in many different directions, with many different technologies competing to become the standard. This causes **compatibility** issues and requires the deployment of extra hardware and software when connecting devices. Additional compatibility challenges stem from non-unified cloud services, lack of standardized M2M protocols and diversities in firmware and operating systems among IoT devices. What's more they are further accompanied by **longevity** challenges, as some of the former technologies are to eventually become obsolete in the next few years, effectively rendering the devices implementing them useless.

Necessary activities (in or for the public sector)




 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>Specific training is necessary in the case of developers, which may be ignorant of the threats of IoT programming and run the risk of dishing out code that is reliable from a functionality perspective, but can easily exploited be exploited remotely[173].</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>The infrastructure needed in order to enable devices to understand their environment and act accordingly involves a combination of sensors, actuators, distributed computing power, wireless communication on the hardware side interacting with applications, and big data on the software side[173].</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>The increased automation that is made possible by IoT calls for internal reforms in various processes, as existing manual as well as semi-automated tasks can be instantly executed thanks to the IoT advancements.</p>

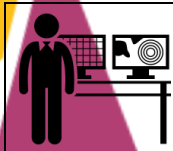


 <p>Promotion / information of stakeholders necessary</p>	<p>Open task</p>	<p>Informative material on both the use and threats of IoT solutions for end users needs to be developed to support them in ensuring their privacy. This should also include information on personal and private data handling IoT devices</p>
 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>Security issues are data related. Health monitoring data is sensitive data and must be treated with the utmost privacy, as they can tell a lot about the end-user. Hence, securing the data is an open issue and must be a top priority for the success of the adoption of the particular technology.</p>
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>Additions or amendments to the legislative framework are necessary as regulations about the privacy and security of data are to play a critical role. Attention is drawn to the fact that only in late January 2013, some relevant recommendations were provided by the Commission nationale de l'informatique et des libertés (CNIL), an administrative regulatory body whose mission is to ensure data privacy[173].</p>
 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>One of the main obstacles for a full adoption of connected devices and the Internet of Things as a consequence is the lack of standards. As long as there are no predominant standards, connected devices will not convince common users, aside from tech-savvy early adopters. To achieve maturity, the creation of a stable market with compatible protocols is needed. Moreover, a smooth transition from IPv4 toward IPv6 is critical for the spread of the connected devices[173]. The importance of consistency across the IoT industry is also underlined by the creation of the Global Standards Initiative on Internet of Things (IoT-GSI), which promotes a unified approach in telecommunication standardisation for the development of technical standards[174].</p>
 <p>Need for a more economical solution</p>		<p>There is no need for a more economical solution, as IoT devices and sensors have reached a maturity level that are cheap enough for deployment.</p>

Dealing with challenges		
 Ethical issues		No ethical issues identified.
 Societal issues	Open task	Societal issues concern the rise of unemployment as a result of the greater dependence upon technology and the fewer requirements in human resources.
 Health issues		No health issues identified.
 Public acceptance		<p>The technology is indeed likely to encounter problems regarding public acceptance. End-users' apprehensions about privacy and security will decide upon the success of connected devices and the Internet of Things in the area of health and well-being[173].</p> <p>Further to that, the less user-friendly the products will be, the fewer customers will want to use it. With open standards, data would be simpler to share. And once the Internet of Things is as easy as an app, the adoption rate will see a boost of its adoption[173].</p>

Roadmap for machine learning

Description and state of the art	
 Definition	<p>Machine learning is a term that refers to a set of technologies that evolved from the study of pattern recognition and computational learning theory in artificial intelligence. It is closely related to (and often overlaps with) computational statistics, while it has strong ties to mathematical optimization, which delivers methods, theory and application domains to the field.</p> <p><i>Machine learning</i> is the subfield of computer science that "gives computers the ability to learn without being explicitly programmed" (Arthur Samuel, 1959)[175]. It explores the study and construction of algorithms that can learn from and make predictions on data. Within the field of data analytics in particular, machine learning is a method used to devise complex algorithms that lend themselves to prediction. Such algorithms are composed of many approaches in machine learning, such as deep learning, neural networks and natural-language processing, used in unsupervised and supervised learning that operate guided by lessons from existing information[162].</p> <p>Originally, targeting to achieve artificial intelligence, machine learning has shifted its focus towards tackling solvable problems of practical nature, whereas it has benefited from the increasing availability of digitized information, and the possibility to distribute that via the Internet[176].</p>
 Addressed societal /business or public sector need	<p>Societal need:</p> <p>Inclusive well-being and health</p>
 Existing solutions /applications /services	<p>The following solutions are available for implementing machine learning applications:</p> <ul style="list-style-type: none"> • IBM's Machine Learning[105] • Google AI[177] • Microsoft Azure Machine Learning[178] • Apache Mahout[179] • AmazonML (Amazon Machine Learning)[180] • BigML[181] • Google Prediction API, a Machine Learning black box for devs[182] • Wise, Machine Learning for Customer Success[183]



Main actors regarding R&D of this technology






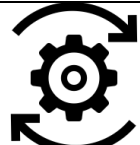

- IBM
- Google
- Apache Foundation
- Imperial College of Science, Technology and Medicine
- Universitat Politecnica de Catalunya
- University of Edinburgh
- University of Oxford
- Institut National de Recherche en Informatique et en Automatique

















Current research activities

Indicative R&D projects include:





- **MLPM** ("Machine Learning for Personalized Medicine"), with the goal to educate interdisciplinary experts who will develop and employ the computational and statistical tools that are necessary to enable personalized medical treatment of patients according to their genetic and molecular properties and who are aware of the scientific, clinical and industrial implications of this research[184].
- **SACCSCAN-IA-ML** ("Developing Machine Learning Classifier Models for Eye Movements to Diagnose Major Psychiatric Disorders"), on the development of SaccScan, a novel point-of-care (PoC) software diagnostic system which has been demonstrated to detect schizophrenia with better than 95% accuracy and can be extended with the same precision to other major psychiatric conditions[185].
- **DecoMP_ECoG** ("Decoding memory processing from experimental and spontaneous human brain activity using intracranial electrophysiological recordings and machine learning based methods"), a project to use intracranial electrophysiological recordings from the surface of the human brain to investigate encoding, retrieval and consolidation of category-specific information during experimental settings, as well as during spontaneous brain activity[186].
- **HF-PREDICT**, on the development and validation of the first clinically accurate wearable device and machine learning software for predicting Heart Failure (HF) of a patient[187].
- **HealthSCOPE**, on the delivery of a healthcare scheduling and management system which will enable hospitals to schedule the use of operating theatres, labs and other facilities, allocate staff, select the required equipment and consumables, and allocate bed space for recovery based on the use of cutting-edge machine learning techniques[188].





 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Degree of Resources (Capital, Personnel, Infrastructure) Utilization • Efficiency / Productivity • Quality of Services Provided <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Productivity • Public Safety • Transport Infrastructure • e-Security 	
<p>Necessary technological modifications</p>		
 <p>Potential cases</p>	<p>use</p>	<p>Machine learning systems can be used in the waiting room of a general practitioner to ask the patient about his/her symptoms and suggest the doctor a first diagnose on which the doctor can agree or disagree.</p> <p>DNA sequencing, as well as health data from large pool of users could be used to diagnose diseases and possible health issues, resulting into new studies and more evident based treatment theories.</p>
 <p>Technological challenges</p>	<p>Technological challenges concern the availability and reliability of data, upon which machine learning applications are to be trained.</p> <p>Moreover, as data becomes big data, new algorithms and computational methods are necessary to accelerate the production of results, in acceptable times</p>	
<p>Necessary activities (in or for the public sector)</p>		
 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>Users do need to be trained in order for machine learning applications to produce reliable results, both on the mathematical/algorithmic level, as well as data engineering levels.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>Need for Big Data infrastructure.</p>
 <p>Change of (public sector internal)</p>		<p>No change of public sector internal processes is necessary.</p>











processes necessary		
 Promotion / information of stakeholders necessary	Open task	There is a need to promote the advantages of Machine Learning alongside with its precondition for accessing and processing large numbers of data, to allow stakeholders to trust these data intense processes.
 Need to deal with cyber security issues		No cyber security issues identified.
 New or modified legislative framework or regulations necessary	Open task	Regulations concerning the use of anonymised personal data would be needed to exploit the full of this technology.
 Development of a common standard necessary		No standards' development is necessary.
 Need for a more economical solution		No need for a more economical solution identified.
Dealing with challenges		
 Ethical issues	Open task	Ethical issues may rise a result of the fact that systems which are trained on datasets, collected with biases may exhibit these biases upon use, thus digitizing cultural prejudices such as institutional racism and classism.












 Societal issues	Open task	Concerns may rise around the greater dependence upon technology and the fewer requirements in human resources. Furthermore, decisions proposed by Machine Learning technology are greatly technocratic, and don't take into account societal impact.
 Health issues		No health issues identified.
 Public acceptance		The technology is indeed likely to encounter problems regarding public acceptance, as a result of distrust against computers substituting human reasoning and decision making.

Roadmap for natural language processing (NLP)




Description and state of the art	
 Definition	<p>Subfield of artificial intelligence and based on the advances in linguistics and machine learning, and closely related with Bots. <i>Natural Language Processing (NLP)</i> is a field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages. As such, NLP is related to the area of human-computer interaction[189]. NLP technology involves the ability to turn text or audio speech into encoded, structured information, based on an appropriate ontology[190].</p> <p>NLP solutions enable communication between human and machine by analysing the content written and spoken in natural human language and converting it into the machine understandable language[191]. Individual challenges within NLP involve natural language understanding, enabling computers derive meaning from human or natural language input, natural language generation, etc.</p>
 Addressed societal /business or public sector need	<p>Public sector need:</p> <p>Digitization</p>
 Existing solutions /applications /services	<p>There are several NLP solutions on the market, such as:</p> <ul style="list-style-type: none"> • Clarabridge NLP[192] • RASA NLU[193] • Ignitho NLP[194] • Innoetics[195] • NLP Technologies[196] • Data Genic NLP[197] • Vocali[198]
 Main actors regarding R&D of this technology	<ul style="list-style-type: none"> • University Of Edinburgh • Centre National de la Recherche Scientifique, University of Oxford • University of Cambridge • Athena Research and Innovation Center in Information Communication & Knowledge Technologies • Stichting Katholieke Universiteit • The University of Sheffield

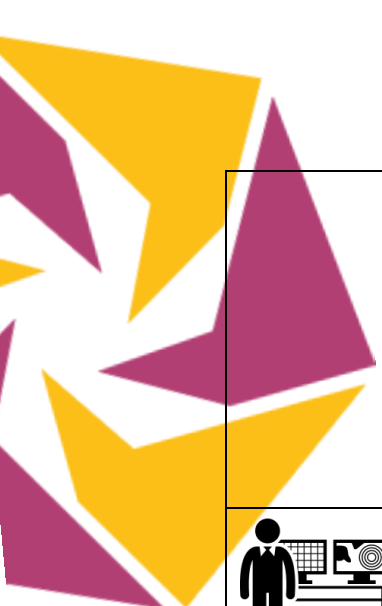
 <p>Current research activities</p>	<p>There are overall 151 projects related to 'natural language processing'. Projects which set the focus on 'natural language processing' itself are</p> <ul style="list-style-type: none"> • HeLeNLP ("Heterogeneous Learning for Natural Language Processing"), with the goal to design new paradigms for large-scale learning of natural language problems in various languages from heterogeneous data sources of variable size, quality, amount of supervision and type[170]. • JointStructuredPred (Machine Learning Methods for Complex Outputs and Their Application to Natural Language Processing and Computational Biology)[199]. • GRAMPLUS (Grammar-based Robust Natural Language Processing), to restore grammatical theory to its necessary place in the theory of human language behaviour, by providing a more restricted theory of constructions than others on offer[200].
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Sustainability • Quality of Services Provided • Level of Participation <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Social equity and inclusiveness • Privacy & Security
<p>Necessary technological modifications</p>	
 <p>Potential cases use</p>	<p>Potential applications of the NLP technology which could cater for the need of the public sector for further digitization include:</p> <ul style="list-style-type: none"> • Conversational interfaces • Automated online assistants • Sentiment analysis • Native language identification • Internet Bots (Robots)
 <p>Technological challenges</p>	<p>Challenges in natural language processing frequently involve natural language understanding, natural language generation (frequently from formal, machine-readable logical forms), connecting language and machine perception, dialog systems, or some combination thereof[189].</p> <p>Natural language processing is successful in meeting the challenges as far as syntax is concerned. But it still has to go a long way in the areas of semantics and pragmatics. The issues still unresolved in semantics are finding the meaning of a word or a word sense, determining scopes of quantifiers, finding referents of anaphora, relation of modifiers to nouns and identifying meaning of tenses to temporal objects[201].</p> <p>Beside the aforementioned theoretical challenges, in NLP, there is also a huge gap between the availability of the solution in general and the availability of a reliable product</p>



		implementing the solution well enough for the real world, and thus being effective for more than one specific domains, languages, means of expression (indicatively social media, etc.) and both short messages and very long sentences.
Necessary activities (in or for the public sector)		
 Development of a specific training necessary	Open task	End user expertise and thereby training is required in corpus analysis or computational linguistics and data science so as to effectively analyse text/speech and build efficient models and ontologies.
 Advanced adapted or ICT infrastructure needed	Open task	The development of domain-specific ontologies or language specific dictionaries is required.
 Change of (public sector internal) processes necessary		No change of public sector internal processes is necessary.
 Promotion information / of stakeholders necessary		No promotion / information provision to stakeholders is necessary.
 Need to deal with cyber security issues		No cyber security issues identified.
 New or modified legislative		No modifications in the legal framework are required.

framework or regulations necessary		
 Development of a common standard necessary		No standards' development is necessary.
 Need for a more economical solution	Open task	There may be the need for more economical solutions in the sense that advanced infrastructure is as well needed, accompanied with big efforts in training systems on recognising language and speech.
Dealing with challenges		
 Ethical issues		No ethical issues identified.
 Societal issues		No societal issues identified.
 Health issues		No health issues identified.
 Public acceptance		No public acceptance issues identified.

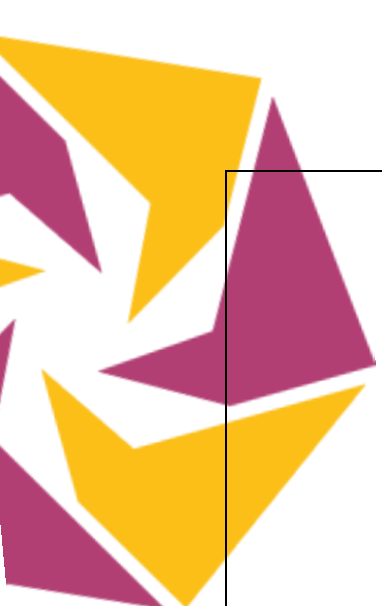
Roadmap for wearables






Description and state of the art	
 <p>Definition</p>	<p>Wearable technology is an extension of ubiquitous computing. It is based on the advances of mobile and wireless interfacing and networking, and in particular WPAN and WBAN specifications.</p> <p><i>Wearables</i> (wearable computers and interfaces) are miniature electronic devices that are designed to be “worn” by humans, such as a wrist-mounted screen or head mounted display, to enable mobility and hands-free/eyes-free activities[202].</p> <p>Wearable computers are especially useful for applications that require more complex computational support, such as accelerometers or gyroscopes, than just hardware coded logic. One common feature of wearable computers is their persistence of activity. There is constant interaction between the wearable and user, so there is no need to turn the device on or off. Another feature is the ability to multi-task. When using a wearable computer, there is no need to stop what one is doing to use the device; its functionality blends seamlessly into all other user actions. These devices can be used by the wearer to act as a prosthetic. It may therefore be an extension of the user's mind or body[203].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Inclusive well-being and health</p>
 <p>Existing solutions /applications /services</p>	<p>“The future use of wearable by health and wellbeing users, [...] will create ecosystem for the population that will be adapted to their changing needs along lifespan in health and disease”[204].</p> <p>Examples of applications/products are:</p> <ul style="list-style-type: none"> • Apple iOS 8 HealthKit[205]: Consolidates health data from iPhone, Apple Watch, and third-party apps and presents an overview of health related data to the user of an iPhone. • Live!y[206]: Lively gives family members insight when a loved one may need their help. • BodyGuardian[207]: wearable monitors that accommodates patient mobility, enhances compliance and streamlines data collection. • Alarm.com[208]: Solution for independent living of











	<p>elderly.</p> <ul style="list-style-type: none"> • ActiveProtective[209]: Hip protection for older adults using wearable airbags. • VitalConnect Band Aid[210]: wearables to check health vitals). • Medical Wearable Solutions Eyeforcer[211]. • Rooti Labs Limited W/Me2[212]. • Cardio family of products[213]. • Biovotion AG monitoring platform[214].
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Commissariat a l’Energie Atomique et aux Energies Alternatives • University Of Surrey • Atos Spain Sa • Institut National de Recherche en Informatique et en Automatique
 <p>Current research activities</p>	<p>In total there are 184 projects related to ‘wearables’. Projects in which wearables play the main role and touch upon the need for inclusive well-being and health are:</p> <ul style="list-style-type: none"> • I-SEE (“Intelligent Sensor Enabled Eyewear”), with the goal to develop and launch in the market a new eyewear product line and a platform of services, focused on improving the health care and wellbeing of eyeglasses wearers, by monitoring the viewing and living experience of the consumers and allowing eyeglasses to interact with smartphones, in-car telematics and professional devices of practitioners and opticians[215]. • WEAKID (“Clinical validation of miniature wearable dialysis machine”), with the goal to validate a miniature wearable dialysis machine in a clinical setting and to prepare the system for CE-marking[216]. • NIGHTINGALE, with the goal to capture and communicate patient data in real time so that relevant clinicians are immediately aware of important risk factors and have early warning of actual deterioration to enable a rapid response[217]. • MONILET (Monitoring Bracelet for Health Use), with the objective to further develop and take to market the prototype of the wearable bracelet and cloud based IT platform for 24/7 continuous medical supervision[218]. • HF-PREDICT, on the development and validation of the first clinically accurate wearable device and machine learning software for predicting Heart Failure (HF) of a patient[187] • ELVIRA, concerning a unique neurorehabilitation device, integrating immersive virtual reality and neurophysiological signals into a wearable headset
















	<p>maximizing independent practice and objective measurement for motor rehabilitation in hospital and home settings after a brain injury or stroke[219].</p> <ul style="list-style-type: none"> • SensMotion, on the development of a wearable sensor system for selective diagnostics of skeletal muscles and motion monitoring[220]. • PersRadSens[221], implementing a personal wearable radon monitor connected to the cloud via smart-phone, tracking the radon exposure during one's whereabouts. • Respiratory Blood Gas, implementing non-invasive, wearable wireless blood gas and respiratory monitoring system[222]. 	
 Impact assessment	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Efficiency / Productivity • Quality of Services Provided <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Entrepreneurship • Innovation • Prosperity & Well-being • Quality of Health • Equity & Inclusiveness • Privacy & Security 	
<p>Necessary technological modifications</p>		
 Potential use cases	<p>Potential use cases involve any device or application that collects healthy aging data, mental data and social data and concern:</p> <ul style="list-style-type: none"> • Sensory integration (helping people see better or understand the world better) • Health care monitoring systems 	
 Technological challenges	<p>One of the major challenges with regard to wearables is the high power consumption. Most wearable devices use wireless networks, GPS, and other technologies that consume a lot of power. Currently, the battery power of wearable devices lasts for one to two days. In the case of intensive usage, the battery lasts for less than a day[223].</p> <p>Another major challenge is the design constraints of wearable devices, which are yet focused on technology rather than on design, and are thus bulkier, as aesthetic sacrifices need to be made for the sake of functionality.</p> <p>Heat and precipitation can further damage wearable devices, and are thus additional challenges affecting their quality and reliability.</p>	
<p>Necessary activities (in or for the public sector)</p>		
 Development of a		<p>No specific training is necessary.</p>




specific training necessary		
 Advanced or adapted infrastructure needed	Open task	Novel interfaces for new types of wearables needed, alongside with novel APIs and gateways.
 Change of (public sector internal) processes necessary		No change of public sector internal processes is necessary.
 Promotion of information / stakeholders necessary		No promotion / provision of information to stakeholders is needed.
 Need to deal with cyber security issues	Open task	The use of the specific technology is accompanied by the risk of hacking and thus misusing wearable devices and thereby the biometric, physiological or health data they contain.
 New or modified legislative framework or regulations necessary	Open task	Adaptations in the legal framework are required to safeguard the privacy of end-users, as wearable devices are able to store a large amount sensitive data (biometric/ physiologic/health data), whereas they use GPS navigation systems to receive location-based information.
 Development of a common standard necessary	Open task	Standards on wearable technologies are still absent, alongside with absence at large of standardised descriptions of the artefacts they measure (such as activity).

 Need for a more economical solution	Open task	<p>The high cost of smart wearable devices is one of the major challenges, curtailing the growth of the relevant market. It is a fact that most manufacturers in this market are launching their products in the premium product category.</p> <p>For instance, the average selling price (ASP) of a smart wearable device is US\$350-380, depending on the application. The ASP of healthcare wearable devices is US\$720-750, while the ASP of fitness and lifestyle products is US\$280-350. In addition, the prices of branded products are very high[223].</p>
Dealing with challenges		
 Ethical issues	Open task	Ethical Issues arise, as wearables track various activities and personal data of their owners.
 Societal issues		No societal issues identified.
 Health issues		No health issues identified.
 Public acceptance	Open task	The technology is likely to encounter problems regarding public acceptance, as wearable devices seem to be awkward for some, whereas there is a general lack of affordability.






Roadmap for virtual reality (VR)







Description and state of the art	
 <p>Definition</p>	<p>Technology evolving from advancements in Computer Graphics, Cognitive Intelligence and Human Computer Interaction.</p> <p><i>Virtual Reality (VR)</i> provides a computer-generated 3D environment that surrounds a user and responds to that individual's actions in a natural way[224]. It refers to computer technologies that use software to generate realistic images, sounds and other sensations (e.g. smell, vibrations, etc.) that replicate a real environment (or create an imaginary setting), and simulate a user's physical presence in this environment, by enabling the user to interact with this space and any objects depicted therein using specialized devices (e.g. display screens, projectors, goggles, headsets or head-mounted displays, gloves, etc.) VR actually brings the user into the digital world by cutting off outside stimuli. In this way user is solely focusing on the digital content[225].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <ul style="list-style-type: none"> • Experiential education and training <p>Public sector need:</p> <ul style="list-style-type: none"> • Recruitment and training
 <p>Existing solutions /applications /services</p>	<p>Existing solutions include:</p> <ul style="list-style-type: none"> • in terms of hardware <ul style="list-style-type: none"> ◦ Google Cardboard[226] ◦ Samsung Gear VR[227] ◦ Oculus Rift[228] • and in terms of software platforms (for schools and universities): <ul style="list-style-type: none"> ◦ Immerse VR Education[229] ◦ Altrange VR[230] ◦ Unimersiv[231] <p>The number of applications for virtual reality training is increasing over time. Thus, also special applications for the public sector (e.g. in the health area or in the area of emergency management) are possible.</p>
 <p>Main actors regarding R&D</p>	<ul style="list-style-type: none"> • Centre National de la Recherche Scientifique • Universitat de Barcelona • University College London • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Technische Universität München













of this technology	
 Current research activities	<p>In total, there more than 160 projects related to virtual reality. Projects identified by SONNETS, and relevant to the related societal need, which set the focus on virtual reality itself are:</p> <ul style="list-style-type: none"> • AbsZero, with the goal to enable a mass audience of private and business customers to record own VR content in a simple fashion and a highly-defined quality through a VR camera[175]. • eHERITAGE (Expanding the Research and Innovation Capacity in Cultural Heritage Virtual Reality Applications), targeting the development of a center of excellence in virtual heritage[232]. • VRMIND (Virtual reality based evaluation of mental disorders)[233], • FURNIT-SAVER (Smart Augmented and Virtual Reality Marketplace for Furniture Customisation), to make use of VR/AR technologies, recommendation engines and a user interface to produce a smart marketplace for furniture customisation[234]. • VR4Health (Revinax platform for 3D Virtual Reality Learning Techniques for Complex Medical Applications), on the development of an innovative solution that will greatly improve surgical training allowing to decrease surgical errors, and the associated burden for EU healthcare systems[235]. • VR STROKE REHAB (Virtual Reality Intervention for Stroke Rehabilitation), to assess the effectiveness of VR therapy to promote the participation in daily physical activity of individuals with stroke[236]. • SP3D (Virtual reality fitting simulation for electronic e-commerce), an innovative solution for customers to try-on clothes on their mobile devices[237]. • MicroNanoTeleHaptics (Micro/Nano Exploration, Manipulation and Assembly: Telehaptics and Virtual Reality System Development and Investigation of Biomechanics and Neuroscience of Touch), developing robot mediated human interface technologies to manually explore, manipulate and assemble progressively smaller objects ranging from micro- to nano-meter scales and demonstrating the power of the interface system in the investigation of the fundamental mechanics and neural mechanisms of touch[238]. • IMOSHION (IMproving Occupational Safety & Health in European SMEs with help of simulatION and Virtual Reality), with the objective to stimulate awareness of OSH issues in European SMEs and to support SMEs in their adherence of OSH through training, operation, planning and the design of workplaces[239]. • IMERSO, a revolutionary Virtual Reality (VR) system





	<p>for modernising the multimedia aspects of product design and prototyping, customer engagement, and workforce training[240].</p> <ul style="list-style-type: none"> • V-TIME (Virtual reality-Treadmill combined Intervention for enhancing Mobility and reducing falls in the Elderly)[241].
 <p>Impact assessment</p>	<p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Quality of Education • Quality of Health • Public Safety
<p>Necessary technological modifications</p>	
 <p>Potential cases use</p>	<p>Virtual Reality can be used in the context of the public sector for several training purposes, indicatively for:</p> <ul style="list-style-type: none"> • Medical training / surgery simulation[242] • Architectural walkthroughs[243] • Historical re-enactments[243] • Emergency services (paramedic training)[243] • Combat training[243] • Rescue teams training • Professional and citizens training for crisis situations • Virtual tours and field trips to museums, landmarks or even outer space • Enhancing the learning experience of students[244]
 <p>Technological challenges</p>	<p>Technical challenges in the field of virtual reality are located in the areas of:</p> <ul style="list-style-type: none"> • developing better tracking systems • finding more natural ways to allow users to interact within a virtual environment • eliminating interface constraints and bad ergonomics (cables impeding movement, poorly designed instruments causing fatigue and an unsettling feeling of enclosure) • decreasing the time it takes to build virtual spaces (it can take a long time to create a convincing virtual environment - the more realistic the environment, the longer it takes to make it) • ensuring platform compatibility.
<p>Necessary activities (in or for the public sector)</p>	
 <p>Development of a specific training necessary</p>	 <p>There is no need for specific training for the use of the technology. However, caution is needed, when it comes to the development of relevant models, as poor models of the real world may provide faulty training results, as well as in the actual use of virtual reality systems (i.e. having short breaks for every 30 minutes of use), so as to avoid related side-effects.</p>

 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>Less than one percent of the 1.43 billion computers in the world have the graphical capabilities needed for VR, according to the research company Gartner[245]. These are definitely high-end computers that are optimized for it, but they're costly, and thus out of reach.</p> <p>On the other hand, virtual reality technology is also very bandwidth-intensive.</p> <p>Last but not least, the need for upgraded hardware isn't limited to just computers. Consoles, cameras, displays and other pertinent gadgets need as well to undergo relevant improvements.</p> <p>These points indicate that for the most part, the technology has either yet to be released, is in early developmental stages or simply beyond the budget of regular consumers[245] and imply the need for advanced or adapted ICT infrastructure.</p>
 <p>Change of (public sector internal) processes necessary</p>		<p>No change of public sector internal processes is necessary.</p>
 <p>Promotion of information / of stakeholders necessary</p>	<p>Open task</p>	<p>The immersive nature of VR makes it a perfect fit for video games as well as training applications. However, while for gamers virtual reality may be an easy sell, it may be hard to get non-gamers to commit to this technology, and thereby promotion of the latter to the targeted stakeholders is necessary.</p>
 <p>Need to deal with cyber security issues</p>		<p>No cyber security issues identified.</p>





 <p>New or modified legislative framework or regulations necessary</p>		<p>No modifications in the legislative framework are necessary.</p>
 <p>Development of a common standard necessary</p>		<p>No standards' development is necessary.</p>
 <p>Need for a more economical solution</p>	<p>Open task</p>	<p>The market of virtual reality gadgets is dominated by high prices. This of course is anticipated to change over time as newer models become more powerful and cheaper to produce, but the fact is that we are not there yet[245].</p>
<p>Dealing with challenges</p>		
 <p>Ethical issues</p>		<p>No ethical issues are identified.</p>
 <p>Societal issues</p>		<p>No societal issues identified.</p>
 <p>Health issues</p>	<p>Open task</p>	<p>Prolonged use may cause side-effects, such as sickness, headache, vertigo, nausea, disorientation etc. Oculus Rift's health and safety documentation alone lists the following as potential symptoms:</p> <ul style="list-style-type: none"> • Seizures • Loss of awareness • Eye strain • Eye or muscle twitching • Involuntary movements • Altered, blurred, or double vision or other visual abnormalities • Dizziness • Disorientation • Impaired balance












		<ul style="list-style-type: none">• Impaired hand-eye coordination• Excessive sweating• Increased salivation• Nausea• Lightheadedness• Discomfort or pain in the head or eyes• Drowsiness• Fatigue• Other symptoms similar to motion sickness <p>The truth is, the long-term effects of VR are still unknown. Many side effects are thought to be only temporary, but long-term research studies are scarce so we don't know for sure[245].</p>
 <p>Public acceptance</p>		<p>The technology is likely to encounter problems regarding public acceptance, as for the time being it is only familiar and attractive mostly to gamers, whereas it involves quite expensive equipment which leaves the majority of consumers "priced out" of the VR market.</p>

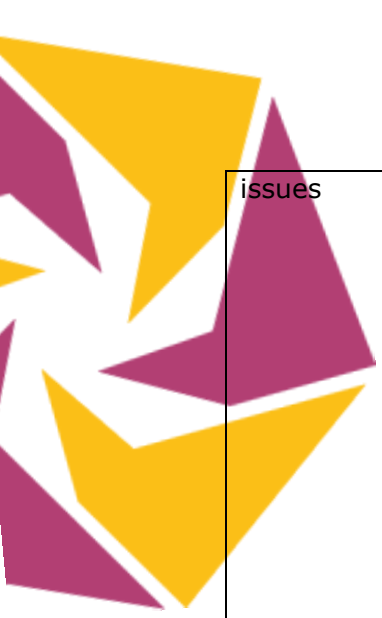




Roadmap for API Economy

Description and state of the art	
 Definition	<p>Trend, based on engineering and software development advances.</p> <p>The API Economy refers to the trend of turning a business or organization into a platform by using Application Programming Interfaces (APIs) to integrate and connect people, places, systems, data, things and algorithms, create new user experiences, share data and information, authenticate people and things, enable transactions and algorithms, leverage third-party algorithms, and create new product/services and business models, thus positively affecting the organization's profitability[246]. An API is a set of subroutine definitions, protocols, and tools for building software and applications by abstracting the underlying implementation and only exposing objects or actions the developers need in order to reduce their cognitive load[247]. Essentially, an API is a customer interface for technology products that allows software components to communicate[248].</p>
 Addressed societal /business or public sector need	<p>Societal need:</p> <p>Faster and transparent access to PS services</p>
 Existing solutions /applications /services	<ul style="list-style-type: none"> • ECIM[249] Smart Mobility API • STORK project[250] • WatchUK, CitaDel, Public Contracts http://public-contracts.nexacenter.org/, Open Coesione[251] (to monitor how EU money is spent) http://www.opencoesione.gov.it/ , Visual OPML[252] (to make available employment data through innovative interfaces) • CitySDK APIs (Amsterdam)[253] • The European Cloud Marketplace for Intelligent Mobility (ECIM) offer APIs for EU wide mobility apps
 Main actors regarding R&D of this technology	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • European Crowdfundfind Network • Technische Universiteit Eindhoven • Ethniko Kentro Erevnas Kai Technologikis Anaptyxis • Europe Unlimited S.A. • Fundacion Centro de Tecnologias De Interaccion Visual y Comunicaciones Vicomtech • Institut Jozef Stefan

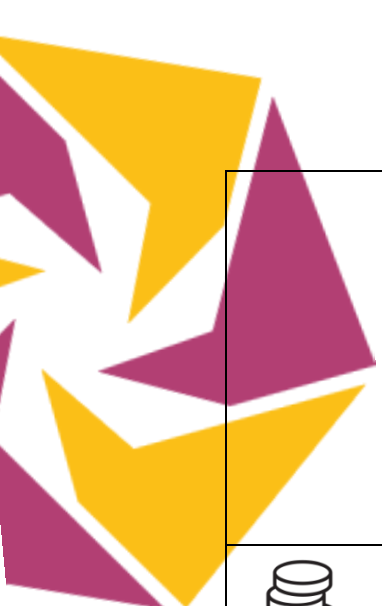
	<ul style="list-style-type: none"> • Universidad Politecnica de Madrid • University of Southampton • IBM • Vordel (now part of Axway)
 <p>Current research activities</p>	<p>EU R&D projects and programmes NEAT and some applications of APIs: CANGOPAL, MusicBricks</p> <p>Other national or international R&D projects and programmes DARIAH-DE (BMBF), KobRA (BMBF)</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Degree of Resources (Capital, Personnel, Infrastructure) Utilization • Efficiency / Productivity • Sustainability • Cross-organization Cooperation • Quality of Services Provided • Image Modernization • Transparency • Creation of Trust & Confidence <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Entrepreneurship • Innovation • ICT Infrastructure • e-Security
Necessary technological modifications	
 <p>Potential cases use</p>	<p>There are quite a lot of potential uses of APIs where public sector releases data to be used by other applications, for example:</p> <p>Emergency situations handled by agencies need to coordinate with other agencies for housing, emergency services, food supplies, etc. Different types of emergencies need different types of support and the ability to put together solutions quickly and integrate with local private sector suppliers quickly can benefit from an API approach.</p> <p>Private sector developers can access government APIs to provide value to citizens and potentially earn some revenue. Businesses may want to access traffic data to find opportunities for marketing (e.g. to people stuck in traffic). Infrastructure planning and zoning are also potential consumers of this data. Population and census data can be made available via APIs for outside developers to access and use in their Apps in creative ways.</p> <p>On the homepage of programmableweb.com there are e.g. 712 API's listed in the area of "government". Several of them will help to present public sector information to citizens and</p>










	businesses, e.g. World Government Data, GeoGratis (geospatial data), opengov.es (data from the Spanish government)[254]
 Technological challenges	<ul style="list-style-type: none"> • Programming knowledge required. • Poor or badly written APIs. • Maintenance required. • Potential of system crash when testing APIs. • Steep learning curve to knowing how to program APIs • No standardised documentation
Necessary activities (in or for the public sector)	
 Development of a specific training necessary	<p style="text-align: center;">Open task</p> <p>Creating new APIs does take some work and developers need to know about the data and programming. However, it's much faster than traditional application development, and requires no rewriting or recoding of source applications.</p>
 Advanced or adapted ICT infrastructure needed	<p style="text-align: center;">Open task</p> <p>The large amount of data put at the disposal of third parties implies placing that data within big data systems for data analytics processes to analyse the data in real time or near real time.</p>
 Change of (public sector internal) processes necessary	<p style="text-align: center;">Open task</p> <p>As derived from the potential use cases described, there is a need for partnerships with private sector, so, in many cases, it is necessary to change internal processes. Besides, and because of API efficiency, government employees can shift from transaction processing and other clerical tasks to other type of activities, which also demands changes.</p>
 Promotion of information stakeholders necessary	<p style="text-align: center;">Open task</p> <p>According to a Deloitte analysis[255] on API economy from a public sector perspective, the full realization of this "API economy" will require government to assemble a community of partners, including those from the open source, to create a thriving ecosystem. Additionally, it is desirable that public sector APIs are collected in a public directory to promote them and encourage its use.</p>
 Need to deal with cyber security	<p style="text-align: center;">Open task</p> <p>Cyber risk considerations should be at the heart of the API economy.</p> <p>APIs expose data, services, and transactions, creating assets to be shared and reused. The downside is the expansion of critical channels</p>



<p>issues</p>		<p>that need to be protected—channels that may provide direct access to sensitive IP that may not otherwise be at risk.</p> <p>Deloitte, in their report about API Economy – From systems to business services[256], poses some leading concerns:</p> <ul style="list-style-type: none"> • Control: who is allowed to access an API, what they are allowed to do with it, and how they are allowed to do it. Managing this concern translates into API-level authentication and access management, controlling who can see, manage, and call underlying services • More tactical concerns focus on the protocol, message structure, and underlying payload, protecting against seemingly valid requests from injected malicious code into underlying core systems. • Routing, throttling, and load balancing have cyber considerations as well—denials of service (where a server is flooded with empty requests to cripple its capability to conduct normal operations). • Privacy and security concerns arise whenever public sector entities share data, especially citizen data.
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>An important issue in the API Economy is data ownership and liability, regardless of whether the APIs are open or protected.</p>
 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>Public sector needs to start making APIs a required component of the projects they undertake, including the use of open and established standards.</p> <p>Standards are there, but it is important to ensure that they are leveraged to ease the data exchange between the different IT systems. According to Liip[257]: Standards like Swagger and RAML can help when implementing API documentation.</p> <p>With regard to the protocol, for server-to-server communication REST APIs based on XML</p>


















		<p>are the standard, while REST via JSON is becoming increasingly popular especially for server-to-browser communication.</p> <p>For authentication, OAuth is the most popular option for user based authentication, while JSON Web Tokens are more or less the go to option when implementing server-to-client authentication. For single sign on SAML should be considered as the go to option.</p>
 Need for a more economical solution	Open task	<p>API Economy in public sector has some associated costs (development costs, maintenance costs, API documentation and support provision to users of the API). But, in the long run, APIs enable fast and transparent access to public sector services, which saves time and money.</p>
Dealing with challenges		
 Ethical issues		No ethical issues identified
 Societal issues		No ethical issues identified
 Health issues		No ethical issues identified
 Public acceptance		<p>There are some facts that are accelerating API adoption in the public sector and the high acceptance levels. Citizens' desire for more data and agility in their public processes, demands for improved customer service, budget pressures to deliver more services with less funding.</p> <p>Those leading the way in the API Economy are the ones that start by identifying high-value use cases that facilitate smoother interactions between citizens, businesses and government agencies.</p>















Roadmap for crowdsourcing

Description and state of the art	
 Definition	<p>Trend, based on the enabling technologies of the internet and social media.</p> <p>Crowdsourcing, a combination of the words 'crowd' and 'outsourcing', is a specific sourcing model, which describes the processes for sourcing a task or challenge to a broad, distributed set of contributors using the Web and social collaboration techniques. It consists in obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers.</p> <p>By definition, crowdsourcing combines the efforts of numerous self-selected volunteers or part-time workers; each person's contribution combines with those of others to achieve a cumulative result. Crowdsourcing applications typically include mechanisms to attract the desired participants, stimulate relevant contributions and select winning ideas or solutions[258],[259]</p>
 Addressed societal /business or public sector need	<p>Public sector need:</p> <p>Civil servants as a community of change</p>
 Existing solutions /applications /services	<ul style="list-style-type: none"> • Spacehive[260] • Goteo.org[261] • Crowdcube crowdfunding platform[262] • Paribas Securities Services and Smart Angels crowdfunding platform[263] • FinStat Data Feeds[264]
 Main actors regarding R&D of this technology	<ul style="list-style-type: none"> • Alma Mater Studiorum-Universita di Bologna • Centre National de la Recherche Scientifique • University of Oxford

 <p>Current research activities</p>	<p>EU R&D projects and programmes IoT Lab, c-Space, FutureEnterprise, CrowdRec, NOMAD, we.learn.it, RESCUER, Citizen Cyberlab, CROWDLAND, CROWDFLOWS, Be-novative, CloudTeams, CroDS, CORAL</p> <p>Other national or international R&D projects and programmes Study about crowdsourcing, Challenge Cloud and Crowd</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Degree of Resources (Capital, Personnel, Infrastructure) Utilization • Sustainability • Quality of Services Provided • Level of participation <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Innovation • Equity & Inclusiveness • Privacy & Security • Transport Infrastructure
<p>Necessary technological modifications</p>	
 <p>Potential use cases</p>	<p>Crowdsourcing works to generate new ideas or develop innovative solutions to problems by drawing on the wisdom of the many rather than the few.</p> <p>There are many potential use cases for crowdsourcing:</p> <ul style="list-style-type: none"> • Knowledge discovery and management (gather information from the citizens about their city) • Distributed human intelligence tasking (behavioural modelling) • Peer-Vetted Creative Production (developing social[265] marketing campaign themes or target messages) <p>But this roadmap refers to crowdsourcing within the public sector, government setting up a micro-tasking platform, not just for citizen engagement, but as a way to harness the knowledge and skills of its own workers across multiple departments and agencies.</p> <p>This can be a way to improve performance, job satisfaction and innovativeness.</p>
 <p>Technological challenges</p>	<ul style="list-style-type: none"> • Recruiting and retaining users can be a challenge. • Types of users' contributions are mostly limited (e.g. review/rate/tag/etc.). • Difficulty in combining and evaluating user contributions - unstructured information gathered, cumbersome to filter. • Good quality of user contributions is not guaranteed. • Difficulty in keeping hold of confidential information and intellectual property.





Necessary activities (in or for the public sector)		
 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>For this new way of working, there should be an emphasis on continuous learning.</p> <p>To broaden public employees' skills and the ability to handle multiple tasks and work on a variety of projects, learning should focus on social and collaborative processes in a distributed workplace.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>		<p>Not necessary. In relation to infrastructure, only a crowdsourcing platform, mobile devices and networks are required.</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>If ideas and tasks are crowded from public sector employees, internal processes should change to incorporate this new approach. It requires rethinking about some traditional workforce practices, designed for clerks of the last century, and would necessitate some changes to current human resource norms (teleworking), focusing on flexible work arrangements to improve public sector recruiting.</p>
 <p>Promotion / information of stakeholders necessary</p>	<p>Open task</p>	<p>It is a new concept and needs to be explained. The motivation can vary from:</p> <ul style="list-style-type: none"> Flexibility, giving more control over their schedules and workloads <p>Public employees could switch from project to project and from office to office as their career develops and interests evolve. When they feel they have reached the limit of their ability to learn or grow in one role, they will look elsewhere for a new opportunity. This avoids confine the knowledge within any single department and allows the government to concentrate resources where needed.</p> <ul style="list-style-type: none"> Focus on results <p>It also implies a greater focus on mission outcomes rather than on back-office management.</p>

 Need to deal with cyber security issues	Open task	Working remotely from different locations poses a major security risk. Besides, virtual team members could be accessing sensitive information from their homes or from a public Wi-Fi networks.
 New or modified legislative framework or regulations necessary	Open task	To accommodate this new way of working in the public sector, there should be a change in the legislative framework, which is nowadays very constricted in terms of tasks that each professional level can undertake.
 Development of a common standard necessary		No issues identified.
 Need for a more economical solution		This crowdsourcing approach is more cost efficient than the traditional approach because a government-wide pool of workers could reduce the burden on each individual agency of maintaining and managing a large workforce.
Dealing with challenges		
 Ethical issues		As the "crowd" is internal, public employees themselves, there are no ethical issues related to IP and ownership of results.
 Societal issues		No issues identified.
 Health issues		No issues identified.



Crowdsourcing within public sector represents a dramatic change so it is bound to be greeted with some scepticism. A good communication is necessary.

Roadmap for digitalization

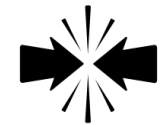
Description and state of the art	
 <p>Definition</p>	<p>Trend, based on the advancements of digital technologies. Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business[266].</p> <p>Digitalization is a sub-process of a much larger technological progress, involving digitization (the conversion), digitalization (the process) and digital transformation (the effect) that are collectively accelerating the global and societal transformation process. In this context, digitization represents the conversion of analog information into digital form that can be understood by computer systems or electronic devices, digitalization corresponds the process of the technologically-induced change, whereas digital transformation is described as the total and overall societal effect of digitalization[267]. In a narrower sense, digitalization as well as digital transformation may refer to the concept of "going paperless".</p>
 <p>Addressed societal /business or public sector need</p>	<p>Public sector need:</p> <p>Increase resource productivity</p>
 <p>Existing solutions /applications /services</p>	<p>We can mention as an example:</p> <ul style="list-style-type: none"> • STORK project[250] • PAE (Portal Administracion electronica)[268] • Cita Previa de Atención Primaria (online medical appointment)[269] • Agencia Tributaria[270]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Universität Koblenz-Landau • Brunel University • Ethniko Kentro Erevnas Kai Technologikis Anaptyxis • Liquid Democracy Ev • University of Leeds • University of Newcastle Upon Tyne



Current research activities

EU R&D projects and programmes
 In the last years, there have been few projects which are dedicated to the digitalization of administrative work in general (e.g. EIII, TEL-CONVERGENCE), but several very specialised projects e.g. cataloguing of ancient artworks, shoe development for diabetic feet.

Other national or international R&D projects and programmes
 Digital Work Design (BMBF), Digitalisation and the future of work (BMBF); **EUREKA** project (Dev. Of a next generation evaluation module for complete tender management software that enables full e-procurement); CDTI (Spain): Digital transformation of the public administration



Impact assessment

Public sector modernization:

- Efficiency / Productivity
- Sustainability
- Cross-organization Cooperation
- Quality of Services Provided
- Image Modernization
- Level of participation

Public Sector as an Innovation Driver:

- Innovation
- ICT Infrastructure
- e-Security

Necessary technological modifications



Potential cases use

Digital transformation promises great things for the public sector and the citizens it serves, from lower costs and greater efficiency to real-time services, seamless communication, and enhanced program effectiveness. Shared services, greater collaboration and integration, improved fraud management, and productivity enhancements enable system-wide efficiencies.



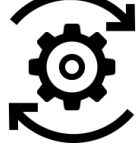

Digitalization in the public sector also provides greater access to services for rural populations, improve quality of life for those with physical infirmities, and offer options for those whose work and lifestyle demands don't conform to typical daytime office hours.














Technological challenges

- High initial investment and maintenance costs.
- Availability of digital equipment (e.g. computer) needed.
- Digital literacy and competence needed both in the back office and in the front desk.




Necessary activities (in or for the public sector)

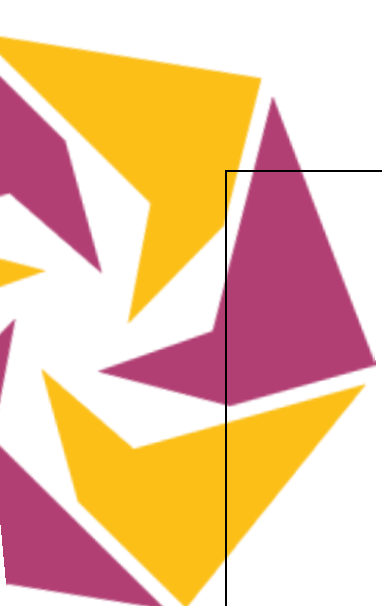
 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>The complexity of large-scale digital projects requires specialized skills and expertise. According to a recent survey of Oxford Economics[271], public sector executives lack confidence in their organization’s digital proficiency. For this reason, cultivating digital skills among both senior leaders and the general workforce should be a priority.</p> <p>The EC has also called eGovernment stakeholders through the eGovernment4EU platform and many answers pointed out the need to upskill civil servants[272].</p> <p>Deloitte[273] identifies these skills necessary for digital transformation in the public sector: technological savviness, user experience design, agile structure, business acumen, collaborative processes and entrepreneurial spirit.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>Public sector’s robust IT infrastructure needed to support new digital tools is often outdated or not easily scalable. Public sector must upgrade, connect and consolidate their infrastructure before it becomes obsolete and unable to support digital and collaborative environments.</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>Digital technology offers public sector organizations an opportunity to operate more efficiently, offer improved products and services, and ultimately better serve citizens. Digital transformation is more than implementing a particular piece of technology, it requires a new framework that allows government to upskill its workforce, remake processes, develop diversity, and attract and retain talent.</p> <p>Digital transformations require changes, to both processes and IT systems, which are more challenging to implement in the public sector than in the private sector.</p>
 <p>Promotion of information / of</p>	<p>Open task</p>	<p>In relation to this point, the need is more oriented to the promotion of digital and economical capacities of some groups of the population.</p> <p>Digital devices are commonplace, but not for all</p>

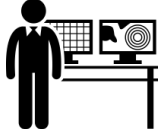

stakeholders necessary		groups of citizens, so there is a need for multiple touchpoints and expect unified, multi-channel experiences.
 Need to deal with cyber security issues	Open task	<p>During the last few years, the World Economic Forum identified cyberattacks and critical-systems failure as two of the most dangerous global risks[274] because, beyond financial losses, cyberattacks may pose serious reputation risks for companies and governments.</p> <p>It's critical to make online security simple for citizens while maintaining strong protections for their private data. Besides, an increasingly mobile workforce can expose government networks to additional vulnerabilities.</p>
 New or modified legislative framework or regulations necessary		No especial needs identified. The necessary regulation is already in place.
 Development of a common standard necessary	Open task	Government institutions need adhere to specific methodologies and guidelines when planning their digital strategies to reduce unnecessary investments, enforce common standards, and build greater project synergies.
 Need for a more economical solution	Open task	Although it is necessary to invest in a comprehensive public sector digital transformation, it results in savings of time and money. In fact, and according to a McKinsey study[275], capturing the full potential of government digitization could free up to \$1 trillion annually in economic value worldwide, through improved cost and operational performance.
Dealing with challenges		
 Ethical issues		No issues identified.

 Societal issues	Open task	While process automation and self-service are a must to accommodate growing (and demanding) citizen populations, there are some groups that may be left behind: elderly, impaired, less well-off citizens...so there is a need to bridge the digital divide.
 Health issues		No issues identified.
 Public acceptance	Open task	Public organizations are not only tasked with doing more with less money, they must also meet increasing digital interaction demands from technology savvy constituents.

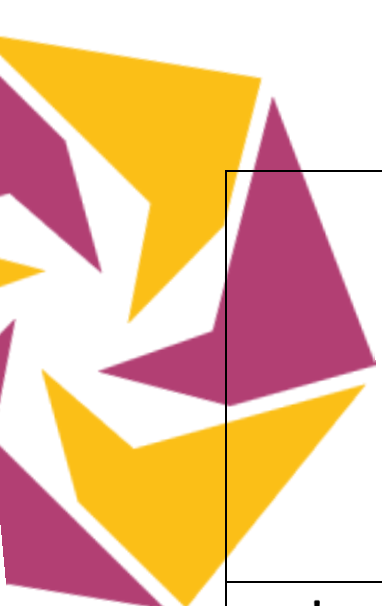
Roadmap for e-participation




Description and state of the art	
 Definition	<p>Trend, based on the developments in CSCW (Computer Supported Cooperative Work) and groupware, e-democracy and e-government. It can be considered as part of e-democracy.</p> <p>E-Participation refers to the ICT supported participation in processes involved in government and governance. Such processes may concern administration, service delivery, decision making and policy making. E-Participation is hence closely related to e-government and e-governance participation. According to a more detailed definition, e-participation is the use of ICT to broaden and deepen political participation by enabling citizens to connect with one another and with their elected representatives.[276]</p> <p>The OECD defined three practical ways in which these interactions could be strengthened:[277]</p> <ol style="list-style-type: none"> 1. Information: Government disseminates information on policy-making on its own initiative – or citizens’ access information upon their demand. (One-way relationship) 2. Consultation: Government asks for and receives citizens’ feedback on policy- making. (Two-way relationship) 3. Active participation: Citizens actively engage in decision-making and policy-making. (Advanced two-way relationship)
 Addressed societal /business or public sector need	<p>Societal need:</p> <p>Participate access to public sector services (political participation)</p>
 Existing solutions /applications /services	<p>There are already many e-participation platforms running, both governmental ones as well as from private organisations. However, the popularity of these e-participation platforms varies from country to country:</p> <ul style="list-style-type: none"> • mySociety (UK)[278] • change.gov (US)[279] • Citizen Space[280] • Futurium[281] • Puzzled by Policy[282] • SOLVIT[283] • OurSpace[284]



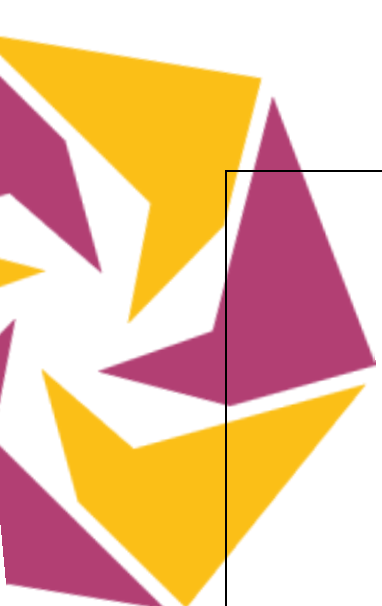
	<ul style="list-style-type: none"> • Reddit[285] • Loomio[286] • Agora Voting[287] • kosovakosovo.com (Serbia, Kosovo)[288] • OpenKratio[289] • VTaiwan[290] • Policy Compass[291] • Sirvo A Mi Pais[292] • Frankfurt fragt mich (Frankfurt asks me)[293] • FUPOL applications[294] • Better Reykjavik[295] • Gothenburg, Online forum[295] • The Malmö Initiative[295] <p>A study about the potential and challenges of e-participation in the European Union[296] summarizes that e-participation encompasses three interactions: e-information, e-consultation and e-decision-making. Existing initiatives that support e-participation already are</p> <ul style="list-style-type: none"> • European Citizens' Initiative (ECI)[297] • Online EU Public Consultations[298] • Petitions to the European Parliament[299]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Ecole Polytechnique Federale de Lausanne • Ethniko Kentro Erevnas Kai Technologikis Anaptyxis • Consiglio Nazionale delle Ricerche • Stiftelsen Sintef • University of Patras
 <p>Current research activities</p>	<p>The Europe for Citizens Programme (2007-2013) promoted initiatives that facilitate the active participation in the civic and democratic life of the EU.[300]</p> <p>The eParticipation Preparatory Action – supported by the European Parliament - co-funded 21 pilots promoting the use of ICT in legislative and decision-making processes within parliamentary and government environments.[300]</p> <p>The CIP ICT Policy Support Programme for 2009 supported projects empowering and involving citizens in transparent decision-making in the EU.[300]</p> <p>A large FP7 programme in this area has been the Integrated Program Future Policy Modelling project (FUPOL).[294]</p> <p>The EU's 5th & 6th Research Framework Programmes (FP5/6) co-funded several projects to develop concepts, tools and solutions for the use of ICT in participatory democracy. Tools for governance and policy modelling, developed under FP7, will</p>






	<p>support governments in delivering smarter, targeted and adaptive policies, whilst better understanding cost-effectiveness and impacts.[300]</p> <p>The CIP/PSP Projects 'OurSpace', 'Puzzled by Policy', 'MyUniversity', 'Immigration Policy 2.0' and 'PARTERRE' achieved concrete and good results.[300]</p> <p>There is also an EUREKA project (Achieving increased citizen participation and engagement via electronic voting)[27] in this area.</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Image Modernization • Level of political participation • Political transparency • Creation of trust and confidence in the public sector <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Social equity and inclusiveness
<p>Necessary technological modifications</p>	
 <p>Potential cases use</p>	<p>There are already many e-participation applications available – for specific problems (e.g. public bathrooms in Frankfurt[301], public city park in New Karonlinelund[302]), for specific target groups (e.g. young citizens – Our Space[284]), on an European level (e.g. European Citizens Initiative[297]), on a national level (e.g. OSALE - The Estonian eParticipation Tool[303]) or on city level (e.g. The Malmö Initiative[295]).</p> <p>The main challenge is to find an already similar solution in another city or country and adapt it to the necessities of the target group.</p>
 <p>Technological challenges</p>	<p>A Finnish study has identified some challenges regarding e-participation on the basis of a crowdsourcing technique, e.g. the risk of misrepresentation of the general populations' preferences. The lack of an authentication process on the website allowed citizens to theoretically have as many profiles as they want, meaning the existence of fake profiles must be taken into consideration. [304]</p> <p>The 'Puzzled by Policy' project concluded that there was too much focus on the development of the ICT part of e-participation. More attention should have been dedicated to collaborating with policy stakeholders at the EU level and involving EU citizens through better advocacy strategies. [305]</p> <p>Julia Reda MEP from the German Pirate Party and her team identified the following challenges of e-participation: accreditation, transparency, anonymity or real name policies, usability, and the potential of</p>








	<p>gamification.[306]</p> <p>The European Citizen Action Service (ECAS) recommends to improve online EU public consultations by making them more accessible and less technical.[307]</p> <p>ECAS further recommends improving the cost-effectiveness, user-experience and the regulatory framework of the European Citizens Initiative. For online EU public consultations it was recommended, to reduce their complexity and always make sure to publish the results on time and accurately and ensure meaningful feedback.[307]</p> <p>Sebastian Vogt and his team came to the conclusion that the technical requirements regarding the applied ICT solutions seem to be a particularly substantial barrier to reaching a broad range of citizens and involving them in participation projects. The different ICT solutions need to be interoperable to improve user-friendliness by providing a clear overview of the projects. Moreover, it is challenging to prepare and display information in a comprehensive and convenient format. Providing citizens with all of the necessary information is a prerequisite for their informed participation in the projects.[308]</p> <p>Panopulou and his team recommend to [309]</p> <ul style="list-style-type: none"> • Design a system that is appealing, yet simple and easy to use • Consider error handling, easy reversal of actions, and helpdesk • Ensure system's appropriateness for the targeted participants <p>The project 'Puzzled by Policy' states also that the experience gained during the design and implementation of the Inform-Consult-Empower approach revealed that the main challenges to be faced are not technical, but rather socio-political.[310]</p>
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Necessary activities (in or for the public sector)

 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>Panopoulou and his team recommend to [309]</p> <ul style="list-style-type: none"> • Educate and train staff • Acquire skilled personnel
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 <p>Advanced or adapted infrastructure needed or ICT</p>		<p>Not issues identified in this area.</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>According to the Finnish study [304] the lack of an institutionalised process leads to an arbitrary final result. The Finnish Minister of Environment, and not the citizens, had to take the ultimate decision to change the law. In order to avoid citizens' frustration, it is important to guarantee their opinions are going to be taken into consideration in the final step. The Finnish parliament should have introduced a binding process or obligation to include the citizen's proposals in the law change. The European Citizen Action Service (ECAS) has performed a SWOT analysis on e-participation and has concluded that the European Citizens' Initiative leaves citizens more frustrated due to its lack of impact. Another weakness connected to this point is that the results of the ECI are not-binding. Also online EU public consultations are unlikely to have a meaningful impact on EU decision-making. It is recommended to always publish the results of EU public consultations and meaningful feedback to ensure transparency and accountability. It is important to make sure that the results are also published on time and that they are an accurate analysis of the public consultation.[307]</p> <p>Estonian government officials have initiated interactive online tools such as TOM and osale.ee for engaging citizens online, but management and promotion of these tools often is neglected over time and therefore these channels are used by rather low numbers of citizens. In the question of administrative culture, supporting measures range from clarity in institutional duties to ensure democracy development to making changes in civil servants' job descriptions in order to become more responsive toward citizen interaction.[295]</p>



Promotion /
information of
stakeholders
necessary

Open task

A Scottish study concluded that e-government tools cannot reach their potential if the engagement process they are embedded within is not **promoted** and does not allow citizens to engage in a meaningful and accessible manner, within a suitable timeframe.[307]

The 'Puzzled by policy' project concluded that a lot of human resources were required to develop citizens' engagement on the platform. It is essential **to create partnerships with mediators** in the policy field which can help support the process. When involving hard-to-reach groups of citizens in policy-making, combining online and offline participatory approaches are needed.[305]




The European Citizen Action Service (ECAS) recommends to[307]

- Keep **promoting** the European Citizens Initiative (ECI) as a tool that encourages participation and active citizenship in the EU
- Keep **encouraging citizens** to use the ECI to express their own interests and make sure they have a chance to put those interests on the EU's agenda by using it.
-

The European Citizens Initiative and the Online EU Public Consultations are currently largely unknown to the public.[307]

Sebastian Vogt and his team came to the conclusion that the benefit of complementary offline activities that support the e-Participation project is acknowledged. Additional actions such as **organizing local events, offering participation via telephone or postcards, which when distributed in advance can also serve as an advertisement for the online portal**, ensure the success of e-Participation projects.[308]

Weber and his team conclude that **public acceptance can be viewed as a basic requirement** for the success of all political participation measures whose promotion should receive an appropriate priority.[311]

 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>There persists the threat of manipulation by organised groups (especially in small scale applications).</p> <p>Panopoulou and his team recommend in their review paper to [309]</p> <ul style="list-style-type: none"> • build an absolutely secure system • protect participants' personal data (privacy) • ensure confidentiality from third parties (e.g. hackers) but also from government • convince citizens that the system is fully secure and private.
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>When using e-participation tools, organisations must follow their own policies and procedures relating to record-keeping, data security, intellectual property and privacy. It may be helpful to develop guidelines for safe and acceptable use and publicise these to users.[312]</p> <p>Important supporting factors are legal environment, administrative and political culture. In the case of its legal environment, Estonia has removed most regulative barriers that would hinder transparency or access to information. However, there are some areas where regulations should be updated, according to technology-driven changes in society. For example, the issue of internet freedom versus copyright and privacy protection is an ongoing debate on a global scale.[295]</p>
 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>For the pan-European tool, European Citizens Initiative coordination should be simplified as it is currently unnecessarily complex due to the lack of harmonised rules for identification requirements.[307] There is also the need for Member States to agree upon a European common set of requirements, which should include facilitating the signing of European Citizens Initiative by expats as they currently cannot sign an European Citizens Initiative in their country of residence.[307]</p>



Need for a more economical solution

Open task

The European Citizen Action Service (ECAS) has performed a SWOT analysis on e-participation and has concluded that the European Citizens' Initiative (ECI) [297] is not **cost-effective**, considered the great efforts required to organise it and the low certainty of impact.[307] It recommends to improve the cost-effectiveness of the ECI by reducing the efforts to use it and by clearly (re)defining the outcomes of successful ECIs and start fulfilling them.[307]

Whilst the tools are generally free to use, e-participation can be **resource intensive** – particularly in terms of staff time and skills. There may be a need for staff to provide support for new users, which should decrease over time. However, there will need to be a commitment from staff to publicise the service widely in order to generate interest, and to encourage people to participate in discussions on an ongoing basis.[312]

Because of the anonymity afforded online and the increased distance between participants, some people may engage in behaviour or provide responses that are irrelevant, unhelpful, inappropriate or abusive. Organisations will need to consider in advance how they will respond to such behaviour. There may be a need to moderate contributions from users, especially in comments and discussion forums, and this can be **expensive and time consuming**. [312]

Dealing with challenges









Ethical issues

Open task

There persists a threat of **digital divide** (both in terms of digital infrastructure and in terms of citizens experience with e-participation)[304, 312]

The European Citizen Action Service (ECAS) has performed a SWOT analysis on e-participation and has concluded that a significant weakness of the European Citizens' Initiative[297] is that **requirements for identification and personal data are excessive**. It recommends to reduce the excessive identification and personal data requirements to enhance participation.[307]






		<p>The Scottish Health Council concluded that e-participation can also create barriers to people being able to access or use the service. Most online content is in the form of text, and similar challenges exist as for other forms of written communication including literacy levels and language comprehension – compounded by the fact many people prefer or find it easier to read from a printed document rather than an electronic screen.[312]</p> <p>Some people may feel intimidated by online participation, especially if they feel that they lack digital skills or literacy. The anonymity of participants and the loss of cues such as tone of voice or body language can make it more difficult for people to feel engaged. It is also more difficult to follow up conversations which are not taking place in real time. A combination of online and offline engagement methods is advisable.[312]</p> <p>It is a problem that e.g. online EU public consultations are rarely representative for EU citizens.[307]</p>
 Societal issues		No societal issues identified.
 Health issues		No health issues identified.
 Public acceptance		<p>According to the UN e-Government Survey 2016[313]</p> <ul style="list-style-type: none"> • E-decision making, the most challenging aspect of public participation, rose substantially among the top 25 countries in EPI, from 36% in 2014 to 62% in 2016. • E-consultation has seen remarkable growth in 2016 topping 91% from 73% in 2014. <p>Both the European Citizens Initiative and the Online EU public consultations are considered to be not user-friendly. The single access point for information about online EU public consultations, Your voice in Europe, is</p>

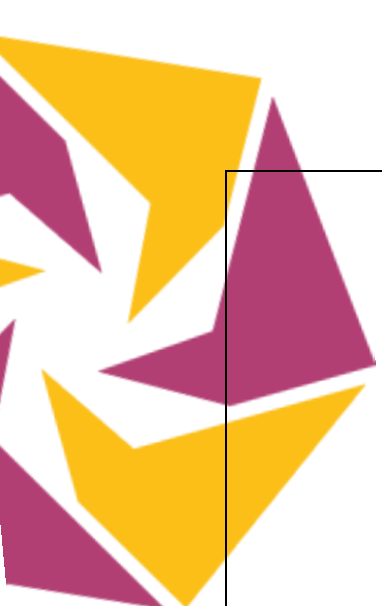





		unattractive, intransparent, not user-friendly and ineffective.[307]
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Roadmap for gamification

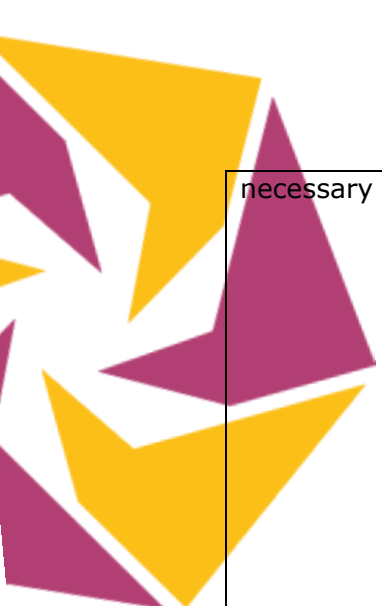
Description and state of the art	
 <p>Definition</p>	<p>Trend, based on the use of game mechanics.</p> <p>Gamification is the use of game mechanics to drive engagement in non-game business scenarios and to change behaviours in a target audience to achieve business outcomes. Many types of games include game mechanics such as points, challenges, leaderboards, rules and incentives that make game-play enjoyable.</p> <p>Gamification applies these to motivate the audience to higher and more meaningful levels of engagement. Humans are “hard-wired” to enjoy games and have a natural tendency to interact more deeply in activities that are framed in a game construct[314].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Public sector need:</p> <p>Employee remuneration and incentives</p>
 <p>Existing solutions /applications /services</p>	<ul style="list-style-type: none"> • Economie.gouv.fr[315] • The UVA baygame[316] • PEPC, MISIVIAS[317] • Games of Social Change by Engagement Lab @ Emerson College[318] • MIT, Education arcade[319] • MMOWGLI Portal[320]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Telefonica Investigacion y Desarrollo SA • Institut National de Recherche En Informatique et en Automatique • Universidad Politecnica de Madrid
 <p>Current research activities</p>	<p>EU R&D projects and programmes</p> <p>RAGE, GALANOE, PLAYMANCER, PERGAMON and also several projects with very different applications of Gamification: air traffic management: PACAS; Cars: Safe and Sound Drive; Education: STIMULATE, SIREN, ILearnRW, ManuSkills, TARGET, GaLA, ADAPTIMITES, ProsocialLearn, BEACONING, TheCityGame pilot, Q-Tales, FACE, Environment:</p>





	<p>Waternomics, WaterWatt, TRIBE, ENTROPY, EnerGAware, PEAKapp, GreenPlay, ECO – ENGAGE, health: DOREMI, BLINDPAD, VERVE, HEALTHNAR, IRIS, 3D-Tune-In, police, first responder: LEILA, INSPEC2T, TARGET, CITYCoP, AUGGMED, policy, government: SYMPHONY, xDELIA, JobCity</p> <p>Other national or international R&D projects and programmes</p> <p>PlayFM – Serious Games for knowledge transfer in facility management, Serious Games in nursing training; EUREKA project (Gamified school information system), EUROSTARS projects (LBSaaS) and (FRAIL)</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Efficiency / Productivity • Image Modernization • Level of Participation <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Innovation • Quality of Education • Environmental Awareness Creation
<p>Necessary technological modifications</p>	
 <p>Potential cases use</p>	<p>Generally speaking, gamification can be part of every organization’s digital business strategy:</p> <ul style="list-style-type: none"> • Services supporting collaboration among teams – Provision of work incentives. • Awareness on and adoption of systems. • Education and awareness raising, gamified systems are used to motivate people to learn online <p>Within the public sector, gamification can be used to help public agencies run communications campaigns, raise awareness of new or undervalued initiatives, engage citizens, train officials and even change behaviour.</p> <p>In this roadmap, gamification is considered as a way to motivate public employees. Adding game elements to the job is expected to raise motivation, as players take on challenges, receive immediate feedback on their performance, and can compete against others. Building self-esteem and re-enforcing it with peer recognition is a powerful means of unlocking motivation.</p>
 <p>Technological challenges</p>	<ul style="list-style-type: none"> • Unclear effects on user attitudes and behaviours. • Simplification and limitation of the game elements employed. • One-size-fits-all approach that impedes customization of the game mechanics for specific user groups. • Legal restrictions applying to gamification with regard to the use of virtual currencies and virtual assets, data privacy laws and data protection, or labour laws.













	<ul style="list-style-type: none"> • Target groups being mostly youngsters and those familiar with gaming. • Need for expertise in information systems, organization behaviour and human psychology.
Necessary activities (in or for the public sector)	
 <p>Development of a specific training necessary</p>	<div style="text-align: center;"></div> <p>Game mechanics comes natural for most part of the people, so public employees will not need any special training associated with this.</p>
 <p>Advanced or adapted infrastructure needed</p>	<div style="text-align: center;"></div> <p>To introduce gamification into public sector processes does not imply the need for an advanced complex infrastructure. In fact, what gamification does is to create a digital environment where people compete to win prizes as part of a game, and through the process, learn something new or behave in a desirable manner.</p> <p>So, the problem does not lie in the infrastructure, the hard part is designing the game correctly.</p>
 <p>Change of (public sector internal) processes necessary</p>	<div style="text-align: center;">Open task</div> <p>Public sector internal processes need to be changed, as gamification affects employees progress paths, the use of feedback and rewards, user interfaces, etc. to make it easier to share information and engage internally. An interdisciplinary approach, with a user-centred philosophy, is recommended for best results when designing processes.</p> <p>For example[321, 322], each user, in consultation with colleagues and managers, could set concrete goals and concrete standards of success or failure. Such an approach may allow for various work processes to be tailored to a specific audience, while allowing for personalization based on individual preferences.</p>
 <p>Promotion of information / of stakeholders</p>	<div style="text-align: center;"></div> <p>According to Dan Hunter and Kevin Werbach, both professors at the University of Pennsylvania, adoption of gamification in the public sector could be greater than in the private sector because public sector employees are mission-oriented - "Gamification taps into motivations other than money or tangible</p>









<p>necessary</p>		<p>rewards. People play games because they find them enjoyable and they care about the outcomes. Workers in public service organizations are likely to respond to gamified systems that are effectively connected to the organization’s mission.” In conclusion, gamification is likely to succeed in the public sector because money is less of a motivator than in private industry. Public service environment just can’t rely on greater monetary rewards to make people do things.</p> <p>When it comes to the different generations, we can say that gamification is particularly relevant to young people, digital natives, now entering the workforce. New employees may find a gamified workplace more attractive because they value work experiences that are supportive, fun, engaging and rewarding. But gamification holds also great value for their colleagues of different generations, as the workings of games are as universal as the excitement they produce. In fact, according to a KPMG study[323], more mature individuals can be more responsive to gamification experiences than their younger peers.</p>
 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>Security should be at the top of every organisation’s agenda, irrespective of whether gamification is implemented in their processes or not.</p> <p>Applying gamification inside an organization where employees interact with a gamified system, generates - due to the nature of the concept - a track record of their achievements and the collection and use of personally identifiable data.</p>
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>It becomes necessary to look at the legal aspects of gamification: labour laws, data privacy and constitutional rights, depending on the countries the employees are located and accessing the gamified systems.</p> <p>For example, there will be a need for new or modified legislative framework to deal with the ethical challenges identified below.</p>





 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>If standards are met it is more likely that a game can be ported from one platform to another and be applied in multiple administrations with minor adaptations.</p>
 <p>Need for a more economical solution</p>		<p>Gamification is basically a digital engagement model, which can be packaged into an app or device and scaled to engage an audience of any size at a very low incremental cost.</p>
<p>Dealing with challenges</p>		
 <p>Ethical issues</p>	<p>Open task</p>	<p>According to Kim, T.W. & Werbach, K.,[324] practitioners and designers should be precautionous about, primarily, but not limited to, whether or not their use of gamification practices: (1) takes unfair advantage of workers (e.g., exploitation); (2) infringes any involved workers' or customers' autonomy (e.g., manipulation); (3) intentionally or unintentionally harms workers and other involved parties; or (4) has a negative effect on the moral character of involved parties.</p>
 <p>Societal issues</p>		<p>No issues identified.</p>
 <p>Health issues</p>		<p>No issues identified.</p>
 <p>Public acceptance</p>		<p>Awarding virtual badges and points as employees complete assignments will result in a more engaged, productive and happier public workforce and this is also beneficial for the citizens they serve. So, gamification within public sector is likely to be very well accepted.</p>



Roadmap for mobile devices

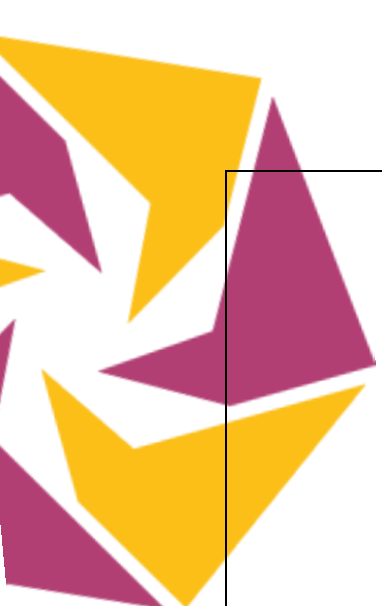
Description and state of the art	
 Definition	<p>A mobile device (or handheld computer) is a small computing device, typically small enough to hold and operate in the hand and having an operating system, capable of running mobile apps. These may provide a diverse range of functions. Typically, the device will have a display screen with a small numeric or alphanumeric keyboard or a touchscreen providing a virtual keyboard and buttons (icons) on screen. Many mobile devices can connect to the internet and interconnect with other devices via Wi-Fi, Bluetooth or near field communication (NFC)[325].</p>
 Addressed societal /business or public sector need	<p>The identified Societal need was the faster and transparent access to PS services. The identified public sector needs were increase resource productivity and digitization.</p>
 Existing solutions /applications /services	<ul style="list-style-type: none"> • Conduit[326] • CatSalut Respon • PlatgesCat[327] • ECIM[249] Smart Mobility API • Gov2go app (personal government assistant)[328] • Commercial Driver License (CDL) practice knowledge test mobile application[329] • Mobile inspections app for agencies to easily conduct inspections in the field right from a tablet[330] allows users in Thailand to make police reports using their phones, instead of having to locate a police station. DubaiNow, Unified Government Services App, to enable citizens transact with government services through a single platform[331]. • Whim, Mobility-as-a-Service App, linking all transport networks in Finland and suggesting travel routes using all available means of transport^{Error! Bookmark not defined.} • Qlue, City Improvement and Monitoring App (Jakarta)^{Error! Bookmark not defined.} • Most of the existing solutions are related to cloud services and connected mobile devices. There are plenty of providers of such solutions, some of them combining hard- and software solutions. Companies like T-Systems are offering dynamic workplace IT infrastructure. The most popular end-user solution is Microsoft Office 365. On stores like Apple's App Store[332] and Google's Play Store[333] users can find thousands of apps under the category



	<p>productivity.</p> <ul style="list-style-type: none"> • Gives flexibility of workers to work from any place they want to. • Allows for better integration of work and private life • Facilitates working on business trips and saves costs because of shared workspace
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Technische Universiteit Delft • Universidad Politecnica de Madrid
 <p>Current research activities</p>	<p>There are a lot of projects dealing with mobile devices in general – in CORDIS 279 projects have been published. Specifically, in the area of mobile devices in the public sector the following projects are running: Innovative mobile e-government applications: THUNDHUB, NAV4I, PW, A-BAM, Mobile E-Admini, MPGS, TAIS, PRIFOG, Foodakai-1 , ICT-enabled open government: Mobile-Age</p> <p>Call of the German Federal Ministry of Education and Research 'smart services of the cities'[334]; EUREKA project (Use of mobile devices such as tablets & smartphones for data collection, data processing & operational process management)[335]</p> <p>DG 'Internal Market, Industry, Entrepreneurship and SMEs' has published a call regarding 'Innovative mobile e-government applications by SMEs' in 2013 [336] and on 'INSO-1-2015 - ICT-enabled open government'[337] in 2015. In 2013, the European Commission published an orientation paper in which research and innovation activities in the area of 'ICT-supported co-created, personalised and high impact public services, including the use of social media and smart mobile devices' were recommended[338].</p>
 <p>Impact assessment</p>	<p>Public Sector Modernization:</p> <ul style="list-style-type: none"> • Institutional/Capacity Development • Efficiency/Productivity • Quality of services provided • Image Modernization <p>Public Sector as an Innovation Driver:Innovation</p> <ul style="list-style-type: none"> • Privacy & Security • Transport Infrastructure • e-Security • Environmental Awareness Creation

 <p>Potential use cases</p>	<ul style="list-style-type: none"> • M-learning. • Mobile services. • Booking and payment of health services. • Reservation of doctor appointment in mobile. • Transport-related services (traffic updates, footprint monitoring)
 <p>Technological challenges</p>	<ul style="list-style-type: none"> • Internet access required for certain functions. • Variable connectivity. • Hindering real human interaction. • Increasing the probability of accidents.











Necessary activities (in or for the public sector)




 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>Before using this technology a specific training is needed.</p> <p>In the public the implementation of a specific training for different stakeholders is discussed for using mobile devices in the public sector.[339] On the one hand it may be necessary to train the general public and on the other hand the staff in the public sector. These training could be set up by educational institutions as well as private providers.</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	<p>Open task</p>	<p>For the implementation of this technology an advanced or interoperable ICT infrastructure is needed.</p> <p>The existing IP network has to be strategically built into a medianet: optimizing the connectivity for all areas in the country and the available bandwidth to make sure that new features can be used without problems (entry to documents, possibility to make video conferences etc.).[340]</p> <p>In the literature some technologies and trends are mentioned that can function as enablers for the ICT structure in a country for the implementation into the public sector[341]:</p> <ul style="list-style-type: none"> • Open governance systems and how the public sector can create open ICT-supported platforms for public value creation. • ICT-supported co-created, personalised and high impact public services, including the use of social media and smart mobile devices. • Open participation and engagement supported by ICT across all areas of public sector operation. • Experiments with ICT-supported open,






		<p>bottom-up and social innovation involving large numbers of actors.</p> <ul style="list-style-type: none"> • Infrastructures, processes and interoperability integrating different parts of the public sector, and linking the public sector with other actors. • The innovative use of open and big data by the public sector and together with other actors, including policy modelling tools. • Measurement and monitoring tools for use by the public sector itself or other actors. • Further development of Web 2.0 tools and the introduction of Web 3.0 methods. • Empowering the civil servant and making work processes more efficient and effective. • Identity management, personal data protection and data security.
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>The experts' opinion was that there needs to be a change of processes in the public sector for the successful implementation of mobile devices in the public sector.</p> <p>Through mobile devices the connectivity of persons can be increased. Still it has to be guaranteed that everyone will have easy access to not make people and workers frustrated, for example in rural areas[342]</p> <p>Also some things need to be implemented to successfully work together in the public sector via mobile devices: virtual desktops and mobile videos to participate in web conferences.</p> <p>Because of the connectivity it will be possible for people working in the public sector to work from home. New policies will have to be introduced to handle this new form of work.</p>
 <p>Promotion / information of stakeholders necessary</p>	<p>Open task</p>	<p>The technology has to be explained and promoted among business stakeholders or citizens to make sure that all the citizens and stakeholders are able to work with mobile devices in the public sector.</p> <p>Guideline and fact sheets could be part of a strategic implementation of these mobile devices.[343]</p>










 Need to deal with cyber security issues		<p>No specific need for the implementation of mobile devices into the public sector to deal with cyber security issues was identified.</p> <p>Still in literature some risks are discussed with regard to cyber security and data protection as there are risks associated with the inappropriate use of the information available on mobile devices and the sharing of information that is not supposed to be shared.[343]</p>
 New or modified legislative framework or regulations necessary		<p>There is no need for a new or modified legislative framework or new regulations.</p>
 Development of a common standard necessary		<p>No need for a new common standard was identified.</p>
 Need for a more economical solution	<p>Open task</p>	<p>The implementation of mobile devices in the public sector seems to be a challenge with regard to the costs. It will be necessary to find shared services that can provide several technologies and still stay within a reasonable cost limit.[343]</p> <p>Another challenge will be to have a managerial oversight to ensure that costs are contained.[343]</p>
<p>Dealing with challenges</p>		
 Ethical issues	<p>Open task</p>	<p>The technology is likely to raise ethical issues.</p> <p>This can also be connected to some fears regarding the misuse of the availability to access and share information from everywhere.</p>
 Societal issues		<p>No societal issues were identified.</p>

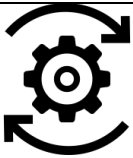


 Health issues		No health issues were identified.
 Public acceptance	Open task	The technology is likely to encounter problems regarding public acceptance.



Roadmap for open data and open government









Description and state of the art	
 <p>Definition</p>	<p>Open government and open data are two highly intertwined concepts.</p> <p>Open Government stands for the governing doctrine which holds that citizens have the right to access the documents and proceedings of the government to allow for effective public scrutiny and oversight. Overall, Open Government is widely seen to be a key hallmark of contemporary democratic practice and is often linked to the passing of freedom of information legislation[344]. In addition, the adoption of an open government approach enables the implementation of a government as a platform paradigm[345] in which private entities are involved in the delivery of services of public interest.</p> <p>Open Data plays a crucial role allowing the implementation of open government practices. As a matter of fact it refers to the idea that some data should be freely available to everyone to use and republish as they wish without restrictions from copyright, patents and other mechanisms of control.[344]</p>
 <p>Addressed societal /business or public sector need</p>	<p>Business need:</p> <p>Promote an entrepreneurial and star-up culture</p>
 <p>Existing solutions /applications /services</p>	<p>Open data could help entrepreneurs to find necessary information about a specific region or economic or legislative conditions or they may be used as an input for the delivery of service.</p> <p>There are a lot of initiatives which provide businesses with public sector information e.g.:</p> <ul style="list-style-type: none"> • EU Open Data Portal[346] • European Data portal[347] • Policy Compass Portal[291] • Public Contracts [348] • Open Coesione[251] • Visual OPML[252] • RES (Research and Education Space) [349] • 3cixty initiative of the Innovation Action Line Digital Cities[350]



	<ul style="list-style-type: none"> • Good Basic Data for Everyone” initiative in Denmark [351] • Publicspending.net[352]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Intrasoft International SA, • Technische Universiteit Delft, • National Center for Scientific Research, • Demokritos, • Ayuntamiento de Zaragoza, • Foundation for Research and Technology Hellas, • Fraunhofer- Gesellschaft zur Förderung der Angewandten • Athena Research and Innovation Center in Information Communication & Knowledge Technologies, • Open Data Institute • Istituto Superiore Mario Boella • NEXA - Polito
 <p>Current research activities</p>	<p>Open Access for Research: OPENAIRE2020, OPENAIRE, OPENAIRE+, PASTEUR4OA, FOSTER, RECODE, Infrastructure projects (with Open Access components): e.g. GEO/GEOSS, ELIXIR[41], Analytics for Open Data: FutureTDM, LinDA, COMSODE, ALIADA, EUCases, and more than 150 EU projects regarding open data for specialised applications, e.g. in the area of environment (GROW), property data (proDataMarket), active aging (City4Age), energy consumption (HotMaps) or poetry standardization (POSTDATA).</p> <p>ICT-enabled open government(2014): ROUTE-To-PA, YDS, DIGIWHIST, WeLive, OpenBudgets.eu, YourDataStories, ICT-enabled open government (2015): smarticipate, RECAP, Mobile-Age, CLARITY, FLOOD-serv. Projects of other calls: OpenGovIntelligence, STEP, WeGovNow, OpenCube, ENGAGE, DIACHRON, VisiOn, E-GOS, VRE4EIC</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • Leaner and faster service delivery • More transparency and accountability • Creation of trust and confidence in the public sector • Better access to services • Enhanced diffusion of best practices <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Public Sector Innovation as an input for profit activities • Public procurement as leverage for the promotion of the open data paradigm (e.g.: in science)

Necessary technological modifications		
 Potential cases use		<p>Open data as well as open government based applications and services have already been widely experimented by the Commission as well as by Member States. In the following are included some examples promoted by public and private organizations:</p> <ul style="list-style-type: none"> • the European Commission[353] open data portal including data all types of public sector information, • Open Parlamento providing data about the parliamentary activity of the Italian Government[354], • OpenCorporates[354] offering company data for businesses operating within and outside the EU.
 Technological challenges		<p>According the 2016 UN eGovernment Survey[355], the issue that many governments face today is not whether to open up their data, but how to do so. Proper governance and careful consideration of both opportunities and challenges is needed. Opening up government data poses a number of challenges, including issues related to legal frameworks, policies and principles, data management and protection, identity management, privacy and cyber security.</p> <p>In addition, semantic enrichment and intuitive fruition models represent further steps to be considered in order to improve the usefulness of the data made available.</p>
Necessary activities (in or for the public sector)		
 Development of a specific training necessary	<p>Open task</p>	<p>A study[356] conducted by IDC and Open Evidence for DG Connect in 2016 defined data workers as workers who collect, store, manage and analyse data as their primary, or as a relevant part of their activity. Data workers must be proficient with the use of structured and unstructured data, should be able to work with a huge amount of data and familiar with emerging database technologies. They elaborate and visualize structured and unstructured data to support analysis and decision-making processes.</p> <p>The report depicts three scenarios for what concerns the evolution of the European need of data workers and the CAGR varies from 2 to 9% for a total number of data workers needed by 2020 that may be up to over 9 million units.</p>
 Advanced or	<p>Open task</p>	<p>Open data can be published in and processed by so-called open data infrastructures. The work conducted by Zuiderwijk[357] shows that such infrastructures should provide twelve basic functionalities: 1) access, 2) searching,</p>





<p>adapted ICT infrastructure needed</p>		<p>3) navigation, 4) uploading, 5) downloading, 6) data quality, 7) analysis of datasets, 8) visualization, 9) linking and combining data, 10) collaboration, 11) support and help and 12) feedback. Requirements for the open data process are to a large extent related to functionalities of open data infrastructures.</p> <p>Nevertheless, the same study, acknowledges that the presence of a difference among infrastructures in terms of focus and in the functionalities provided may suggest that for users these open data infrastructures complement each other. This can be enhanced if all infrastructures would provide open interfaces to enable users to take advantage of the strengths of each infrastructure. In this way an ecosystem can be created in which the infrastructures are connected and can seemingly exchange information.</p>
 <p>Change of (public sector internal) processes necessary</p>		<p>No issues identified.</p>
 <p>Promotion / of information stakeholders necessary</p>	<p>Open task</p>	<p>A Scottish study concluded that e-government tools cannot reach their potential if the engagement process they are embedded within is not promoted and does not allow citizens to engage in a meaningful and accessible manner, within a suitable timeframe.[307]</p> <p>The promotion of open data/ open government initiatives is of particular relevance when transparency must be complemented with public engagement both for the creation of trust and for the crowdsourcing of control activities to civil society.</p> <p>This is the case for service co-creation activities such as peer-to-patent[358], fix-my-street[359] or openricostruzione[360] where the general public plays a crucial role in the process of turning open data into social value.</p>

 <p>Need to deal with cyber security issues</p>	<p>Open task</p>	<p>The European Commission adopted a Cybersecurity Strategy[361] in 2013 and more recently passed the NIS Directive[362] on security of networks and information systems. The commitment on security is due to the fact that digital technologies have become the backbone of our economy and are a critical resource all economic sectors rely on. They now underpin the complex systems which keep our economies running in, for example, finance, health, energy and transport. Many business models are built on the uninterrupted availability of the internet and the smooth functioning of information systems. Cybersecurity incidents, be they intentional or accidental, could disrupt the supply of essential services we take for granted such as water or electricity. Threats can have different origins - including criminal, terrorist or state-sponsored attacks as well as natural disasters and unintentional mistakes.</p>
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>The ESPI platform has released a report highlighting the main principles to be kept in mind in order to promote an ethical and responsible use of open data[363].</p> <p>The first tension to be managed is the one between the openness and “do no harm” principles. The protection of promotion of transparency and accountability is the basic principle of modern democracies which is not questioned, but that has certain limitations linked to a “do no harm” principle encompassing concepts of privacy and security. One of the criteria to be manage such balance is suggested in the book “Ways to practise responsible development data”[364] is that the “do no harm” is for powerless and transparency and accountability is for powerful.</p> <p>Another important principle identified in the study is the right to consent as an essential ingredient in any process of data acquisition and analysis.</p> <p>Finally the study concludes by highlighting the role of privacy by pointing out that the largest part of the current debate about the responsible and ethical data re-use revolves around the preservation of privacy rights.</p>

 <p>Development of a common standard necessary</p>	<p>Open task</p>	<p>No database is an island. On this premise, the W3C together with a number of other actors such as Geothink, GovEx, the International Open Data Charter Technical Working Group and the US Data Federation is working towards the creation and widespread adoption of standards for open data[365].</p> <p>Standards in the field of open data regulate the processes for data treatment and exposure, the vocabularies used for the description of relationships, the localization of resources through the use of persistent URIs.</p>
 <p>Need for a more economical solution</p>	<p>Open task</p>	<p>The Open Data Institute[366] highlighted the following common costs elements for consideration when developing and open data program: set-up and technical, administrative and governance, skill development and community engagement, sustainability.</p> <p>A number of options are available for the public sector to try reducing the current cost of open data management: investing in automation to reduce the need for human intervention, explore new models of collaboration with the private sector[367], start considering open data not as a duty towards external stakeholders but rather as an opportunity to generate cost saving internal innovations.</p>
Dealing with challenges		
 <p>Ethical issues</p>		<p>No ethical issues identified</p>
 <p>Societal issues</p>		<p>No societal issues identified.</p>
 <p>Health issues</p>		<p>No health issues identified.</p>

 Public acceptance		No public acceptance issues identified.
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Roadmap for personalization

Description and state of the art	
 <p>Definition</p>	<p>Personalization, sometimes also referred to as advanced, user-centric customization, consists of tailoring a service or a product to accommodate specific individuals, sometimes tied to groups or segments of individuals, taking in most of the cases also the context in mind as well. A wide variety of organizations use personalization to improve customer satisfaction, digital sales conversion, marketing results, branding, and improved website metrics as well as for advertising. Personalization is a key element in social media and recommender systems.</p> <p>In the public sector, personalization goes hand in hand with the provision of public services to citizens and businesses at the ultimate level of automation (Level #5 - Personalized Transaction), where eGovernment systems are in a position to pre-fill fields of the service applications, as well as to recommend and suggest services which are of need to the applicant, based on various criteria and possible life events.</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Inclusive wellbeing and health</p>
 <p>Existing solutions /applications /services</p>	<p>With personalized healthcare and personalized medicine healthcare service professionals attempt to</p> <ul style="list-style-type: none"> • determine therapy and drug usage by genomic profiles • use biological information and biomarkers to gauge the risk of disease in individuals • provide best possible therapeutic verifiable outcome with minimal adverse effects
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Institute of Communication and Computer Systems • Ecole Polytechnique Federale de Lausanne • Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek TNO • Telefonica Investigacion y Desarrollo SA Unipersonal



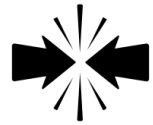
Current research activities

EU Research activities in the area of personalized health care: ProAct, POLYCARE, PICASO, CONNECARE, ICT4Life, C3Cloud, PERMED

German Research Program in the area of personalized health care:
Rahmenprogramm Gesundheitsforschung der Deutschen Bundesregierung, 2011-2019, Aktionsfeld: Individualisierte Medizin

Current Research activities in general:

- Personalization in the area of public service interaction: SIMPATICO (personalized online services), EGOV (online one-stop government), RECAP (regarding common agricultural policy), Mobile Age (for elderly), Flood-serv (floods - emergency and awareness), ROUTE-To-PA (transparency of public administration), WeLive (Open Government),
- By using the once-only principle: TOOP, SCOOP4C,
- Smart and personalised inclusion: RAPP, EIII, BLINDPAD, POSEIDON, Prosperity4All, BNCI Horizon 2020, ABBI, WAI-Dev



Impact assessment

Public sector modernization:

- Degree of Resources Utilization
- Efficiency and Productivity
- Quality of Services Provided

Public sector as innovation driver:

- Equity and Inclusiveness



Potential cases use

Recommendation mechanism to assist citizens in identifying the proper applications/services for addressing a specific need.




Consumers follow four primary strategies to achieve a personalised approach to health and wellness:







- tracking and monitoring: to track specific biophysical or behavioural measures to map their progress towards specific health goals.
- personal coach and trainer: training or instructional programs to assist and support managing lifestyle behaviours to achieve health and wellness.
- decision support: provide a wide variety of information to support decisions about health and wellness.









Technological




- Higher cost
- Anonymity may be preferred
- Lack of relevance
- Can create a "filter bubble" that prevents people from encountering a diversity of viewpoints beyond their own

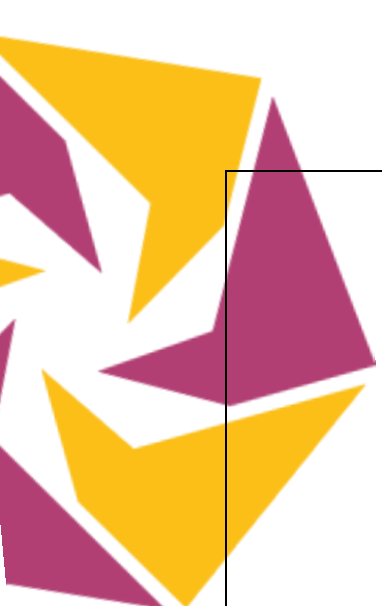
challenges		
Necessary activities (in or for the public sector)		
 <p>Development of a specific training necessary</p>	Open task	<p>Healthcare professionals will need to be educated in their abilities and sense of competence in interpreting personalized medicine tests and in communication with the patient. The communication with the patients is not limited to medical doctors but includes also practice nurses and pharmacists.</p> <p>For next-generation healthcare professionals an education according to an updated curriculum incorporating personalized medicine will be needed.</p> <p>Besides education, healthcare professionals should be aware of (genetic) counsellors and their expertise regarding genetic information, and multidisciplinary team training is suggested.</p> <p>To gain information about biomarkers (including genomic assays) health literacy needs to be increased by clear communication channels to public and patients.[368]</p>
 <p>Advanced or adapted ICT infrastructure needed</p>	Open task	<p>To be supported by tailored information delivery, the development of clinical decision support systems (CDSs) will be needed for healthcare professionals. Automated CDSs address the lack of infrastructure for delivering treatment and care information and should include genomic and non-genomic health data in order to combine genotypes and standard clinical parameters in an interactive informatics portal, including electronic medical records.</p> <p>Healthcare professionals can catch up with latest scientific findings by continuous dissemination of study results on relevant biomarkers and incorporate risk assessment within disease prognosis and treatment prescription, while preventing an information overload. [368, 369]</p>
 <p>Change of (public internal) processes</p>	Open task	<p>Changes in the health care system will be needed.</p>

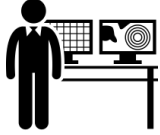


necessary		
 Promotion / of information stakeholders necessary	Open task	Stakeholders in companies, politics, research and healthcare have uncertainties and controversial estimates of the potential development of the personalized medicine. So they need support to formulate a future strategy. [370]
 Need to deal with cyber security issues	?	No literature regarding cyber security issues has been found.
 New or modified legislative framework or regulations necessary	Open task	For a successful realisation of personalized medicine bigger databases with genetic and medical Data will be created. This could lead to violations of the fundamental rights of the patient. So the legislative frameworks have to be defined.[371] Barriers exist in part due to the lack of adequate application of current regulations but also because of a lack of consensus in guidelines on interpretation and use of PM tests.[368]
 Development of a common standard necessary	Open task	Standards at regulatory level should be made for all level of implication and particularly for:[368] <ul style="list-style-type: none"> • infrastructure of biobanking (e.g. clinical study design, accessibility of researchers to data, and intellectual property) • legal and ethical issues (e.g. informed consent, reimbursement, data safety) • automated CDS (e.g. dosing guidelines, interpretations resulting from testing)
 Need for a more economical solution		No issues have been identified.

Dealing with challenges		
 Ethical issues	Open task	Obligations of public and patients to collect and use their biodata is not legal and can be an ethical issue.[370, 372]
 Societal issues	Open task	Attention should be paid to the relation between the social economic status and health literacy, alongside genomic factors that are specific to minorities and/or could be misused for discrimination between societies.[368, 373]
 Health issues		Personalized medicine could be important in the future because it could be a solution in response of the changes in the healthcare system due to the demographic change. Now it is a useful addition for existing types of therapy. [374]
 Public acceptance		No literature regarding public acceptance issues has been found.

Roadmap for policy making 2.0


Description and state of the art	
 Definition	<p>Policy Making 2.0 refers to the adoption of a Web 2.0 approach to the policy cycle composed of four main steps: agenda setting, policy design, policy implementation, monitoring and evaluation. More specifically, the adoption of a more open, bidirectional and discursive approach by government agencies offers interesting opportunities for: i) increasing citizens' participation and engagement, by providing to more groups a voice in discussions of policy development and implementation; ii) promoting transparency and accountability, and reducing corruption; iii) public services co-production, by enabling government agencies and the public to develop and design jointly government services; and iv) exploiting public knowledge and talent in order to develop innovative solutions to the increasingly serious and complex societal problems.[375–377]</p> <p>In addition, Web 2.0 platforms enable government agencies to 'crowdsource' useful fresh ideas from large numbers of citizens concerning possible solutions to social needs and problems, new public services or improvements of existing ones, or other types of innovations.[378, 379] This can lead to the application of open innovation ideas in the public sector[379] and gradually result in 'co-production' of public services by government and citizens in cooperation.[380]</p> <p>According to Lukensmeyer and Torres[381] such 'citizen-sourcing' may change government's perspective from viewing citizens as "users and choosers" of government services to "makers and shapers" of them.</p>
 Addressed societal /business or public sector need	<p>Public sector need:</p> <p>Civil servants as community of change</p>
 Existing solutions /applications /services	<p>There are already a number of platform supporting policy making 2.0 activities platforms running, both governmental ones as well as from private organisations. However, the popularity of these e-participation platforms varies from country to country:</p> <ul style="list-style-type: none"> • Pol.is (TW) [382] • Liquid democracy (INT) [278] • change.gov (US)[279]




	<ul style="list-style-type: none"> • Citizen Space[280] • Futurium[281] • Puzzled by Policy[282] • SOLVIT[283] • OurSpace[284] • Agora Voting[287] • kosovakosovo.com (Serbia, Kosovo)[288] • OpenKratio[289] • Policy Compass[291] • Sirvo A Mi Pais[292] • FUPOL applications[294] • Better Reykjavik[295] • Gothenburg, Online forum[295] • The Malmö Initiative[295] <p>Existing initiatives that support policy making 2.0 already are:</p> <ul style="list-style-type: none"> • European Citizens' Initiative (ECI)[297] • Online EU Public Consultations[298] • Petitions to the European Parliament[299]
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Intrasoft International SA, • Aegean University, • University of Krems, • Technische Universiteit Delft, • Demokritos, • Open Evidence • IPTS JRC
 <p>Current research activities</p>	<p>Most of the projects that focused on the use of social media were financed during the FP7 programme, some examples are: PADGETS, POLICY COMPASS, NOMAD, COCKPIT, OCOPOMO. More recently the focus shifted towards the exploitation of big data approaches. Examples in this area are: Big Data for Better Outcomes, Big data against childhood Obesity.</p>
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> • More effective allocation of tax payers money • More transparency and accountability • Creation of trust and confidence in the public sector • Possibility to leverage collective intelligence <p>Public Sector as an Innovation Driver:</p> <ul style="list-style-type: none"> • Public Sector Innovation as an open innovation platform • Better alignment between companies innovation needs and support services rendered











Necessary technological modifications






 <p>Potential cases use</p>	<p>The adoption of policy making 2.0 solutions may serve different purposes depending on the stage of the policy cycle in which they are implemented. To exemplify they could enable a more effective governance of a given territory by leveraging collective attention, the simulation of potential alternative policy scenarios, the increase of acceptance levels of decisions thanks to a higher level of involvement in the early stages, a higher perceived impact of policy measures thanks to a more engaging and capillary communication strategy. Some concrete examples are listed below:</p> <ul style="list-style-type: none"> • Urban SIM[383] • GLEAM[384] • Economía[385] • Insight Maker[386]
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 <p>Technological challenges</p>	<p>The European Citizen Action Service (ECAS) recommends to improve online EU public consultations by making them more accessible and less technical.[307]</p> <p>ECAS further recommends improving the cost-effectiveness, user-experience and the regulatory framework of the European Citizens Initiative. For online EU public consultations it was recommended, to reduce their complexity and always make sure to publish the results on time and accurately and ensure meaningful feedback.[307]</p> <p>Additional technological challenges are linked with the development of big data and block-chain based solutions for policy modelling and assessment.</p>
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Necessary activities (in or for the public sector)





 <p>Development of a specific training necessary</p>	<p>Open task</p>	<p>The training activities should focus on promoting a more evidence-based culture among civil servants and policy makers as well as on crowdsourcing methods and effective social media communication styles.</p>
 <p>Advanced adapted infrastructure needed or ICT</p>	<p>Open task</p>	<p>New infrastructures may be necessary in the case of blockchain-based solutions such as:</p> <ul style="list-style-type: none"> • Democracy Earth[387] • Bitnation[388] • Flux[389]


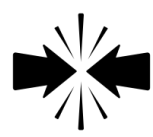




 <p>Change of (public sector / internal) processes necessary</p>		<p>No issues identified.</p>
 <p>Promotion of information / of stakeholders necessary</p>	<p>Open task</p>	<p>A Scottish study concluded that e-government tools cannot reach their potential if the engagement process they are embedded within is not promoted and does not allow citizens to engage in a meaningful and accessible manner, within a suitable timeframe.[307]</p> <p>The 'Puzzled by policy' project concluded that a lot of human resources were required to develop citizens' engagement on the platform. It is essential to create partnerships with mediators in the policy field which can help support the process. When involving hard-to-reach groups of citizens in policy-making, combining online and offline participatory approaches are needed.[305]</p> <p>The European Citizen Action Service (ECAS) recommends to[307]</p> <ul style="list-style-type: none"> • Keep promoting the European Citizens Initiative (ECI) as a tool that encourages participation and active citizenship in the EU • Keep encouraging citizens to use the ECI to express their own interests and make sure they have a chance to put those interests on the EU's agenda by using it.
 <p>Need to deal with cyber security issues</p>		<p>No issues identified.</p>
 <p>New or modified</p>	<p>Open task</p>	<p>When using e-participation tools, organisations must follow their own policies and procedures relating to record-keeping, data security, intellectual property and privacy. It may be helpful to develop guidelines for safe and</p>









<p>legislative framework or regulations necessary</p>		<p>acceptable use and publicise these to users.[312]</p> <p>Important supporting factors are legal environment, administrative and political culture. In the case of its legal environment, Estonia has removed most regulative barriers that would hinder transparency or access to information. However, there are some areas where regulations should be updated, according to technology-driven changes in society. For example, the issue of internet freedom versus copyright and privacy protection is an ongoing debate on a global scale.[295]</p>
 <p>Development of a common standard necessary</p>		<p>No issues identified.</p>
 <p>Need for a more economical solution</p>		<p>No issues identified.</p>
<p>Dealing with challenges</p>		
 <p>Ethical issues</p>	<p>Open task</p>	<p>The use for research purposes of “public” data on social media websites opens the door to deontological issues. The problem is: can those data be used without any ethical or privacy consideration? How the researchers can be sure that their activity is not harmful for some of their subjects? On one hand is impossible to ask for data use permission from all the subjects present in a database. On the other hand, the mere fact that the data are available does not justify their use. Accountability to the field of research and accountability to the research subjects are the ethical keys for data-driven processes. In all the traditional fields of science, researcher must follow a series of professional standards aimed at protecting the rights and well-being of human subjects[390].</p>











 Societal issues		No societal issues identified.
 Health issues		No health issues identified.
 Public acceptance	Open task	The risk of societal resistance may emerge from both internal stakeholders (policy makers) and external ones (society at large). The former may perceive a reduced latitude in the decision making processes while the latter may interpret data-driven policy making as the application of a big-brother approach to societal monitoring and management.

Roadmap for smart workplace





Description and state of the art	
 <p>Definition</p>	<p>A <i>Smart or High Performance Workplace</i> is a physical or virtual environment designed to make workers as effective as possible in supporting business goals and providing value. Such a workplace results from continually balancing investment in people, process, physical environment and technology, to measurably enhance the ability of workers to learn, discover, innovate, team and lead, and to achieve efficiency and financial benefit.[391, 392]</p>
 <p>Addressed societal /business or public sector need</p>	<p>Business need:</p> <p>Talent acquisition and retention;</p> <p>Public sector need:</p> <p>Simplifying recruitment procedures</p>
 <p>Existing solutions /applications /services</p>	<p>Many employees prefer to have a mobile working environment and mobile solutions to help them to improve their work-life-balance:</p> <ul style="list-style-type: none"> • Mobile solutions (smartphones & tablets, wearables, cloud computing) <p>According to a foresight study in 2040[393] e.g. the following properties will characterize a smart workplace:</p> <ul style="list-style-type: none"> • Flexible working contracts (increase mobility and unconventional working patterns) • “wellness” services at the workplace • Focus on collaboration <p>For acqision and recruiting activities Social Media is used.[394]</p>
 <p>Main actors regarding R&D of this technology</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Commissariat a l’Energie Atomique et aux Energies Alternatives • University of Surrey • Katholieke Universiteit Leuven • Atos Spain SA • Aalborg Universitet • Technische Universiteit Eindhoven • Telefonica Investigacion y Desarrollo SA • Thales Communications & Security SAS






 <p>Current research activities</p>	<p>Current research activities in general:</p> <ul style="list-style-type: none"> • EU R&D: INTERACT, Working environment for persons with special needs: MATS, Video Communication Workplace: VIDEOCOM, Smart factory environments: SatisFactory, FACTS4WORKERS, SO SMART • National/Internat.: Living Lab smart office space[173] • Other: Dell & Intel Future Workforce Study - Global Report[395, 396] Smart Workplace Market: Global Industry Analysis and Opportunity Assessment 2016-2026[397] 	
 <p>Impact assessment</p>	<p>Public sector modernization:</p> <ul style="list-style-type: none"> ○ Efficiency and productivity ○ Quality of Services Provided ○ Image Modernization <p>Public sector as innovation driver:</p> <ul style="list-style-type: none"> ○ Productivity (Labor / Capital / Resource) & Growth ○ Innovation ○ Public Safty 	
 <p>Potential use cases</p>	<p>Smart workplaces offer the possibility to change the working environment for employees, to make it more attractive for them.</p> <p>Flexible working environments help to:[398]</p> <ul style="list-style-type: none"> • Acquire and recruit talents from abroad • Open up to globalization (communicate to suppliers and customers working in extreme time zone differences) • Develop fast growing businesses 	
 <p>Technological challenges</p>	<p>With technological solutions there a more flexible working environment can be realised. But more challenging technologies are not that important for a better work-live-balance and thus are not for acquisition and retention of employees. Technologies are only the driver but not of crucial importance.[399]</p>	
Necessary activities (in or for the public sector)		
 <p>Development of a specific training necessary</p>		<p>No issues have been identified.</p>







 <p>Advanced or adapted ICT infrastructure needed</p>		<p>There are already ICT solutions for smart workplaces.</p>
 <p>Change of (public sector internal) processes necessary</p>		<p>No issues have been identified.</p>
 <p>Promotion / information of stakeholders necessary</p>	<p>Open task</p>	<p>Stakeholders need to be aware of the lack of specialists in the following years. This lack of specialists will be the consequence of the demographic change. As a result there should be training possibilities and recruiting and retention strategies.[394]</p>
 <p>Need to deal with cyber security issues</p>		<p>No issues have been identified.</p>
 <p>New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>There is a growing regulatory backlash concerning the 24-hour work culture.</p> <p>Some big German companies have started banning emails out of work time. There are campaigns to put that into law, both in Germany and in France.</p> <p>Volkswagen agreed, after pressure from staff, to stop forwarding emails outside normal working hours. Also Daimler automatically deletes emails sent to staff late at night. Germany then made it illegal for companies to contact their staff when they were on holiday.[398]</p>






 Development of a common standard necessary	<p style="text-align: center;">Open task</p>	No issues have been identified.
 Need for a more economical solution		No issues have been identified.
 Ethical issues		No issues have been identified.
 Societal issues		No issues have been identified.
 Health issues	<p style="text-align: center;">Open task</p>	Non-stop emails and a 24-hour work culture (working 24/7= to be available 24 hours a day seven days a week) because it is expected or there is pressure or it is implied. Additionally there is a rise of insecure employment. This conditions lead to increased health issues like psychological diseases. [400]
 Public acceptance		There is a controversial discussion if flexible smart workplaces implement a good work-live-balance because of the growing 24-hour work culture.








Roadmap for social media / social networking

Description and state of the art	
 <p>Definition</p>	<p><i>Social Networking</i> refers to the act of establishing online many-to-many human connections for the purposes of sharing information with the network or subsets thereof[401], and is based on computer-mediated technologies that make up an online environment allowing the creation, consumption, promotion, distribution, discovery, and sharing of content (e.g. information, ideas, career interests and other forms of expression) via virtual communities and networks[402]. The common features of social networking applications or <i>social media</i> are that they are interactive web 2.0 internet based applications, involving the creation of service-specific user profiles and leveraging user-generated content, and facilitating the development of online social networks. Essentially, social media are web-based services that allow individuals to construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system[403].</p>
 <p>Addressed societal /business or public sector need</p>	<p>Societal need:</p> <p>Participate access to PS services (political participation)</p>
 <p>Existing solutions /applications /services</p>	<p>Today as many as 152 countries out of 193 (four out of five; in Europe 39 out of 43) offer social networking features, such as the “Like” button, on their national portals (i.e. there are links to, for example, Facebook, Twitter, Sina Weibo (in China), Odnoklassniki/VK in the Russian-speaking countries, etc.)[404]</p> <p>For example in the UK 100% of the local governments use twitter, 90% Facebook, 68% YouTube, 54% Flickr and 38% Instagram.[405]</p>
 <p>Main actors regarding of R&D this</p>	<ul style="list-style-type: none"> • Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung e.V. • Ethniko Kentro Erevnas Kai Technologikis Anaptyxis • Universidad Politecnica de Madrid • University of Sheffield • Centre National de la Recherche Scientifique

technology		
 Current research activities	There are more than 230 EU projects in and around the topic 'social media'. With relevance for the public sector the following projects are worth mentioning: STEP, COLEDISO, MULTISENSOR, ENGAGE, COCKPIT and also the CIVITAS initiative	
 Impact assessment	<p>Public Sector Modernization:</p> <ul style="list-style-type: none"> • Cross-organization Cooperation • Quality of Services Provided • Image Modernization • Level of political participation • Transparency <p>Public Sector as Innovation Driver:</p> <ul style="list-style-type: none"> • Environmental Awareness Creation • Social Equity and Inclusiveness (positive and negative impact) • Negative impact on privacy and security 	
Necessary technological modifications		
 Potential use cases	The benefits of social media include helping governments to establish user needs and design more responsive services, instead of just relying on costly and more traditional user needs surveys:[313] <ul style="list-style-type: none"> • Usage of social media to represent the public sector – Social media as vehicles for increased transparency of an agencies actions, e.g. use of the micro-blogging service Twitter to inform journalists and professional groups and direct them to longer updates on a government’s website • Social media enhanced idea exchange platforms for local issues • Social-media enhanced platforms enabling governments to consult citizens on policy issues • Consultation platforms for government employees/Private networks for government employees enabling the exchange of ideas and experiences 	
 Technological challenges	There are no real technological challenges , as many social media services are provided by commercial or non-governmental organizations. Current challenges persist in other areas like e.g. cyber security or issues regarding privacy and data protection.[406]	
Necessary activities (in or for the public sector)		
 Development of a specific training	Open task	It requires digital literacy of public officials and new skills to deal with social media. In fact, it is not enough to place the tools on the national portal if the inputs received are not fully used because of a lack of capacity .[404]

<p>necessary</p>  <p>Advanced or adapted infrastructure needed</p>		<p>Governments do not have to set up their own platforms, as they typically ride on commercial and non-governmental platforms.[313]</p>
 <p>Change of (public sector internal) processes necessary</p>	<p>Open task</p>	<p>Maintaining a Facebook page or Twitter account is relatively straightforward and easy, but will not in itself generate significant public value, cost reduction or increase in citizen trust. For example, e-participation through social media channel needs to be socially re-engineered, taking advantage of the real-time social networking attributes with human interaction and commitment of public servants including those at the senior levels, in order to fully and actively engage citizens in e-information, e-consultation and e-decision-making.[313]</p>
 <p>Promotion of information stakeholders necessary</p>		<p>In general social media are very well known and there is no need for additional promotion. In Europe there are currently (2017) 412 million active social media users (penetration 49%).[407]</p> <p>However, the citizens might not know about the social media presence of their local governance. Data published by Eurostat in 2013 shows that 80% of the EU citizens has internet, but only 41% of individuals used the internet to interact with public authorities or services.[408]</p> <p>Given that 65% of people connect to the internet using their mobile phone, it is likely that this will be done on the move and so making access as easy as possible is a definite plus-point. By publishing content from different platforms you are making people aware that they exist and more likely to follow them.[405]</p>
 <p>Need to deal with</p>	<p>Open task</p>	<p>Social media can also be exploited in a destructive way to invade privacy and raise security issues. Most of the services such as Twitter are tied to a user's cell phone which can be more intrusive than PC-based networks.</p>

<p>cyber security issues</p>		<p>Since Web 2.0 platforms rely on connections and often encourage the user to provide personal profiles, these sites are easily susceptible to hackers. Users' online profiles may be also made available to the general public and attract unwanted attention.[409]</p>
<p> New or modified legislative framework or regulations necessary</p>	<p>Open task</p>	<p>Councils using social media should follow a social media strategy. A good strategy will set what your authority wants to get from using social media, secure buy-in to those aims from across your organisation (including senior leadership), identify any necessary investment requirements, and set clear KPIs for how you will measure success.[405]</p> <p>In the UK currently only 43% of councils have a social media strategy.[405] In Germany only 20% of the municipalities have a written social media strategy. Other municipalities have included their social media strategy in a general e-government or communication strategy.[410].</p> <p>Remaining compliant to privacy requirements is critical for any government body. For large organizations with multiple social media users, establishing best practices for social media use can help ensure the collective compliance of all users. Guidelines towards acceptable and forbidden content, data handling, citizen engagement, and even tone are a few best practice examples organizations can implement to keep their team in compliance.[411]</p>
<p> Development of a common standard necessary</p>	<p></p>	<p>No issues identified (a part from the ones mentioned above regarding a general social media strategy).</p>
<p> Need for a more economical solution</p>	<p></p>	<p>Social media is easily accessible these days and does not cost much more than paying for internet connectivity and hiring a content manager.[404]</p>

 Ethical issues	Open task	<p>One challenge of the use of social media is whether or not all citizens have equal access to the technologies as well as the knowledge to effectively participate in these channels.[409]</p> <p>Thus there might be a widening gap between citizens who are engaged and well-informed compared to those citizens who are disengaged and poorly- informed. With so much news coverage being done through social networks and online channels, traditional news outlets are moving more of their coverage from traditional mediums such as newspapers and television broadcasts to the digital realm.[409]</p>
 Societal issues		No issues identified.
 Health issues		No issues identified.
 Public acceptance		In Europe there are currently (2017) 412 million active social media users (penetration 49%).[407].