



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.

Hong Kong:[126]

- *Property valuations*- 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.

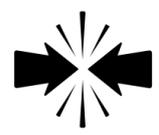
Dubai wants distributed ledgers to power its entire government by 2020.[129]

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

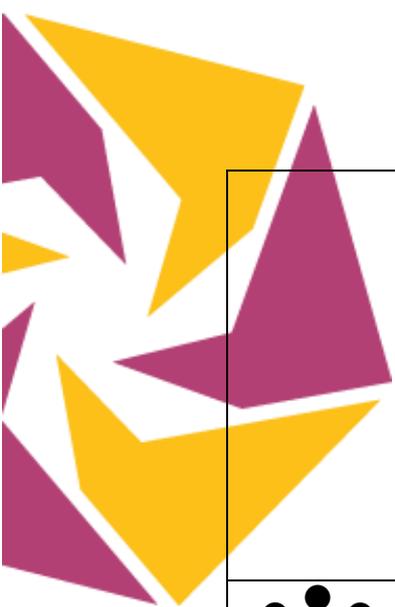
	<p>invoice fraud by using blockchain to create a unique cryptographic hash (a unique fingerprint) for every invoice.[131]</p> <p>In August, Australia Post presented a plan to the Victorian Electoral Matters Committee to use Blockchain for voting.[126]</p> <p>There is a blockchain-as-a-service offering 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 Alpjodleg 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>

