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Roadmap for cloud computing

Description and state of the art	
Definition	*Cloud Computing* 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. 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]. 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].
Addressed societal /business or public sector need	Faster and transparent access to PS services
Existing solutions /applications /services	• 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]

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	• 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] **BMWi:** 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
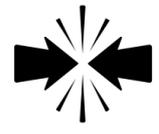
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		• Energy Consumption – Natural Resources Utilization
Potential use cases		• Share ICT resources among multiple agencies • Collaboration applications (e-mail, web conferencing) • Cloud bursting for increased availability at peak seasons (e.g. final exams' results, etc.)
Technological challenges		• 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	**Open task**	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-savy culture[151].
Advanced or adapted ICT infrastructure needed	**?**	One expert highlighted the fact that the public sector mostly does not have an appropriate infrastructure in place. However, certain literature suggests otherwise[152].
Change of (public sector internal) processes necessary	**Open task**	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]). Also, roles and processes within organisation will need to be adapted to the new technologies[152]. Public sector organisations will need to develop their own standards and procedures, e.g. for information risk assessment or data management[151, 152].

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Promotion / information of stakeholders necessary	**Open task**	Citizens and public servants will need to be informed thoroughly on reliability, security and availability of cloud services[151].
Need to deal with cyber security issues	**Open task**	Adoption of cloud computing will pose cyber security challenges, as one expert mentioned for example the access of hackers to stored data. Achieving high security standards and tackling (perceived) security issues is also important to raise public acceptance[151, 154]
New or modified legislative framework or regulations necessary	**Open task**	A legal framework surrounding the use of Cloud Computing will help addressing change resistance. It should be flexible enough to deal with future challenges. 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].
Development of a common standard necessary	**Open task**	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]
Need for a more economical solution	**Open task**	Businesses need be to be incentivised to create appropriate cloud solutions for the public sector[151].
Dealing with other challenges		
Ethical issues		No ethical issues were identified.

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Societal issues	**Open task**	Data protection is an important factor, any cloud solutions should cater to present norms instead of trying to achieve norm change.
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].

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