

The standardization of cloud computing

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Abstract:

Stemming from the actions of a few Internet firms (Google, Amazon, Facebook...), cloud computing initially developed outside any normative framework. In 2012, given the success of this new proprietary form of information technology, traditional European operators in information and communications technology became aware of the need for “fluidity” in this market. Their action led to a set of internationally recognized standards whereby customers are to understand the offers made, data and services are to be portable, and applications are to be interoperable. Between 2014 and 2016, a body of standards (ISO/UIT-T) was released. These standards, recognized by all parties active in this field, are a positive factor in the massive adoption of cloud computing. A list of these standards and an account of how they have been instituted...

France's *Official Journal* defines cloud computing as a third-party service via the Internet for handling customers' data without informing customers about the cloud's location and function.¹ The cloud offers basic services (such as the computation, storage and routing of data), a variety of additional services (related to security, assistance with publication or the creation of applications) and service engagements (such as the availability, duplication or backup of data). Made available via portals, these services can be used upon request via an interface. The service-provider does not physically intervene for installing, executing or uninstalling the necessary applications. Everything is automated, accessible everywhere via the Internet. Standard Y3500 of the International Telecommunications Union defines cloud computing as a “*paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand*”.² These two definitions are complementary: the first from the user's viewpoint; the second, a technical viewpoint closer to service-providers.³

Internet firms (Google, Amazon, Facebook, etc.) developed cloud computing during the first decade of the 21st century, when they had to handle computational requirements that were highly variable, hard to foresee and outside the scope of their usual operations. For the cloud, they put to use computer techniques, some of them rather old but modified considerably. They pushed strongly toward automating infrastructures and decoupling an infrastructure from its applications, to the point that the applications operate by using virtual devices (software images of the hardware). To cope with strong seasonal variations, Amazon opened its infrastructure to outside clients through a portal easy to access over the Internet. It thus uses its infrastructure more intensely outside peak periods of orders. This offer found a market, since the firms subscribing to it can cap their own equipment capacity and free their computer scientists from production tasks.

¹ *Journal Officiel de la République Française* n° 0129 of 6 June 2010, p. 10453, NOR: CTNX1012892X, a synonym of cloud computing in French is *infonyagique*.

² Page 8 of the standard, available via https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-Y.3500-201408-1!!PDF-E&type=items.

³ This article has been translated from French by Noal Mellott (Omaha Beach, France). All websites have been consulted in April 2019

At the start of the 2010s, various businesses (*e.g.*, Salesforce, IBM and Microsoft in the United States; OVH and Thalès in France.) were offering cloud computing services, the main players being Google and Amazon. As it grew, cloud computing trespassed on the traditional computer service market (IBM/Rackspace, Microsoft). In 2011, the sales figure for Amazon's cloud amounted to more than one billion US dollars and represented a substantial percentage of its profits (CGEJET 2011). There was a consensus for *laissez-faire*, an approach dear to Americans (Binder 2013). Private firms would set *de facto* standards and impose them on the marketplace.

Given the growing success of cloud computing offers, other players supported an approach based on more open standards so that consumers can wend their way through the maze of proprietary offers. Concerned about all these offers, the European Commission requested, in 2012, a report on standardization in this field (ETSI 2013). This report was followed by an analysis of users' needs (ETSI 2016).

Meanwhile, telecommunication operators in the networks underlying the Internet and the Web became aware of what was at stake: the Internet players offering cloud computing would eventually replace the traditional data management services provided via specialized connections or private networks. Furthermore, while it was easy enough to subscribe to a cloud, data retrieval was slow. In addition, an application formatted to work in one cloud had to be reconfigured to work in another. Interoperability was not smooth.

Between 2012 and 2016, a set of standards was drawn up under the auspices of two major organizations — the International Standards Organization (ISO) and International Telecommunications Union (ITU) — by work groups with participants from telecommunications and computer science.

Why standardize?

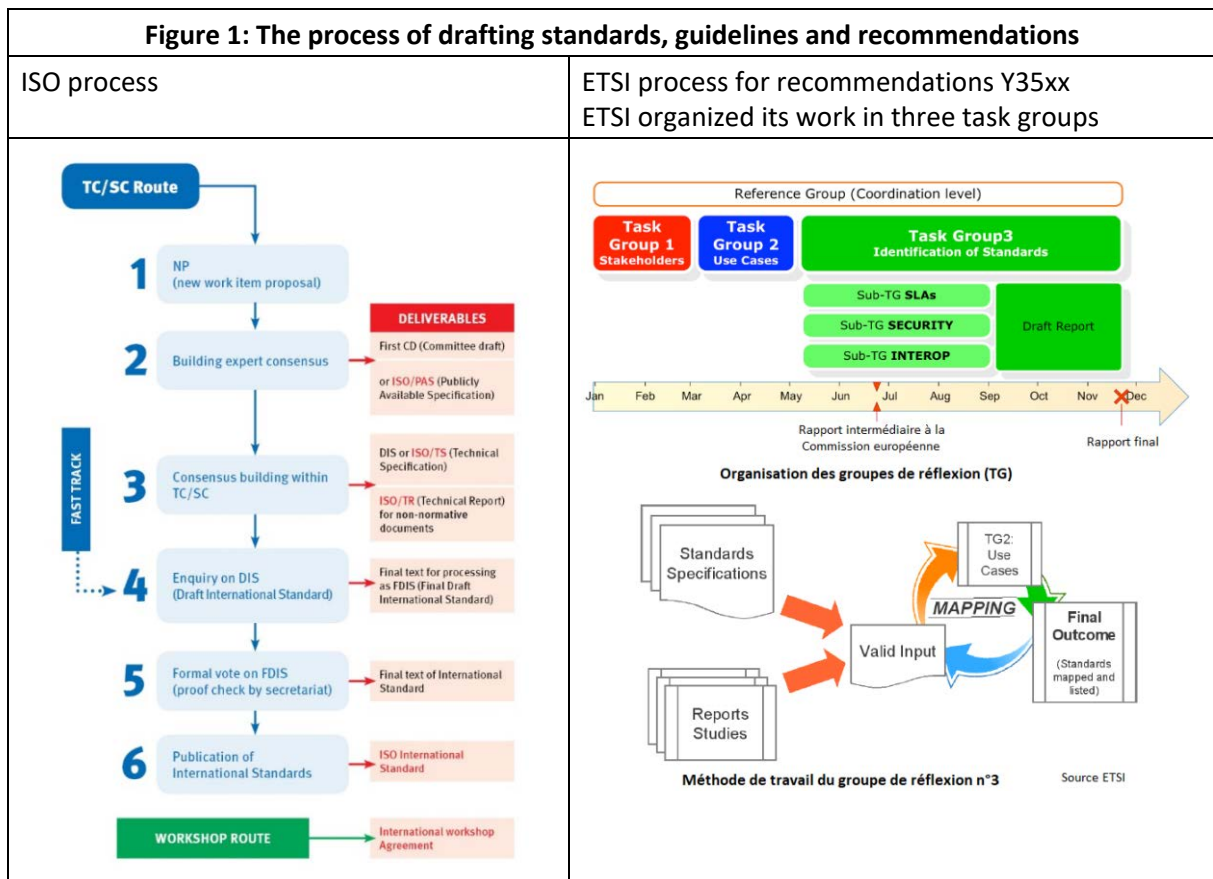
Standardization is “in the DNA” of Europeans, who have developed international standards organizations for more than a century now so as to enable businesses to propose services or products worldwide. Thanks to standards, a common, public set of specifications helps both consumers and manufacturers compare the offers made to them and contributes to interoperability, portability, compliance or security. Standardization has its roots in the deployment of worldwide telecommunication networks (for instance, telephony with the ITU and the Internet with the W3C). For the cloud, understanding, portability and security are major motivations since the customers include firms, self-employed professionals and private persons.

Closed, proprietary formats have left their marks on information technology's history. In 2000 for example, it was very hard, or even impossible, to use a Microsoft Office document on a computer running MacIntosh or to use an Apple document on a computer running Windows. Telecommunication firms remember the 3G standard for mobile telephony and do not want to repeat the experience.

How to standardize?

By nature, cloud computing is worldwide simply because its services are offered to anyone over the Internet. As a consequence, standards have to be worldwide — produced by organizations that most countries recognize. Exit AFNOR or even ETSI. What remains are American or international organizations such as the IEC, IETF and W3C, or the ISO and ITU.

In 2009, the American organizations formed a subcommittee (JTC 1/SC 38) of the joint technical committee of the ISO and IEC that had the assignment to propose standards for cloud computing and distributed platforms. It published its first standards in 2012, most of them about platforms. The only standard on cloud computing would be modified in 2016: ISO/IEC 17826 “Information technology - Cloud Data Management Interface (CDMI)”, which has to do with the interface for accessing data stored in the cloud and managing them. As of 2012, this subcommittee worked with the ITU; and a first set of joint standards was proposed in 2014 (*cf.* Figure 1).



Given the rising offer of cloud computing services, European operators turned to the ITU and ISO, organizations that were more generalist and enjoyed recognition worldwide.

The process of standardization involves two tasks: a technical task that results in drafting the text for a standard, and governance, which results in a consensus about the standard’s utility and interest.

In 2012, Jamil Chawki (Orange) chaired the ITU-T work group on the cloud and then the equivalent group at the ISO (JTC 1/SC 38). With the support of IBM, Microsoft and Oracle, he pushed back against Google and Amazon, and pointed to the need for a set of standards about the cloud. During a second phase, the Internet firms were either observers at these work groups or absent; and they remained neutral when the standards were to be released. A consensus was reached at the end of 2013, and the first standards were published, often jointly by the ITU and ISO. Two basic standards were released in 2014: Y3500 (vocabulary) and Y3502 (architecture).

Rivalry between the ITU and ISO was bypassed by distributing the standards to be drafted between the two. In practice and on a given subject, the work is done by one of the work groups of these two organizations depending on the competence required. For example, security, data protection and portability are jobs for the ISO; but vocabulary and architecture, for the ITU.

The 2013 ETSI report lists 26 organizations that might publish standards or recommendations related to cloud computing: 12 of them have brought out publications, many of which are devoted to the virtualization of network functions, a topic close to cloud computing.

The development of cloud computing also involves processes not specific to this topic. I might mention ISO 9001 (2015) on quality and ISO 27001 on the overall design of security.

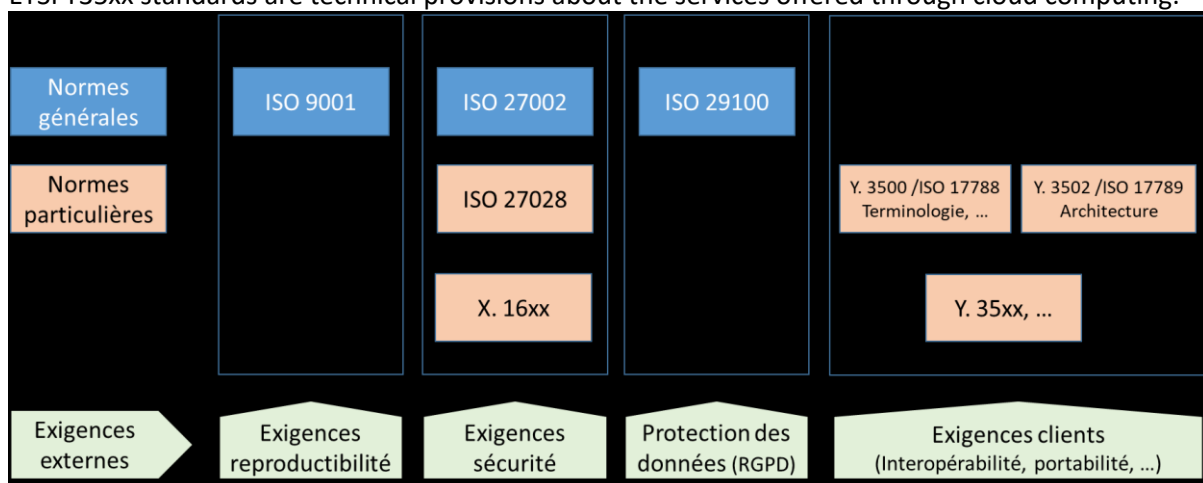
Standards on cloud computing

Cloud computing is based on a set of standards. Some of these standards are not specific to it (e.g. ISO 27002, a recommendation with security guidelines), whereas others are relevant to an application (e.g., ISO 27028, a recommendation on security requirements for cloud computing). General standards are for the businesses that provide cloud-computing solutions or services; professional users of information technology understand them. During the phases of design and production, stakeholders might also follow other standards about information and communications technology. The specific standards mentioned in Figure 2 have to do with aspects of cloud computing itself.

Figure 2: Example of a set of standards and recommendations for the cloud.

NB: ETSI X 16xx standards have to do with security as applied to cloud computing and its supervision.

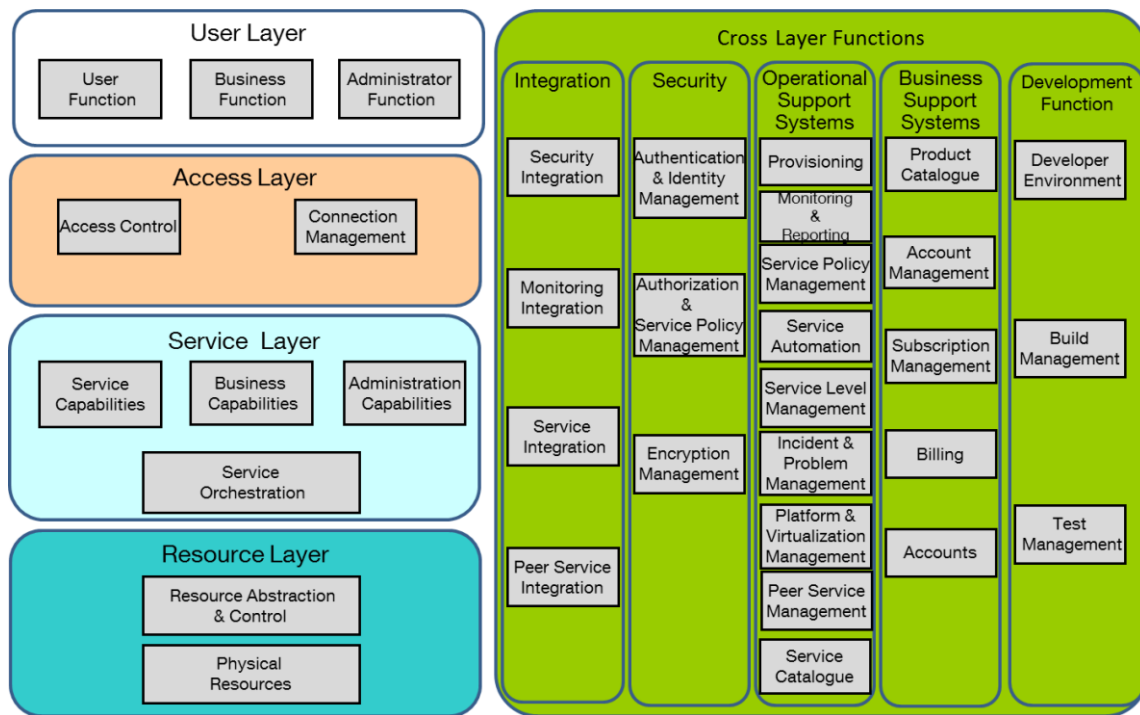
ETSI Y35xx standards are technical provisions about the services offered through cloud computing.



ISO/IEC 17788:2014/ITU Y3500 and ISO/IEC 17789:2014/ITU Y3502 provide the grounds of this form of information technology. They are clearly accepted by the stakeholders in cloud computing.

ISO/IEC 17788:2014/ITU Y3500, “Overview and vocabulary”, establishes the definitions for understanding the offers made by cloud computing services. It defines seven categories of services: SaaS: Software as a service, PaaS: Platform as a service, IaaS: Infrastructure as a service, NaaS: Network as a service, CaaS: Communication as a service, CompaS: Computing as a service and DSaaS: Data storage as a service. The main characteristics of these services are described along with the models for delivering them: public (open to everyone), private (limited to certain clients) or mixed (a combination of the two) (Chawki 2014). This list is not exhaustive, since stakeholders have created other categories in the meantime. The ITU has adapted its work to these new developments for services such as: DaaS: Desktop as a service (under recommendation Y3503).

Figure 3: Reference architecture of cloud computing: Layers and function components
 Source: ITU Y3502 & ISO/CEI 17789.



ISO/IEC 17789:2014/ITU Y3502 on “reference architecture” describes the activities of cloud computing and its functional components. This architecture is divided into four layers (user, access, services and resources) plus a crosscutting field for the functions of integration, security, management and the development of new services.

Readers will find in the two tables the standards and recommendations (as of May 2018) that are of special interest to cloud computing.

Table 1: Standards that are applicable or being developed under the direct responsibility of ISO/IEC JTC 1/SC 38 Secretariat		
	Stage	ICS
<i>ISO/IEC 17788:2014/ ITU Y3500</i> Information technology - Cloud computing: Overview and vocabulary	60.60	01.040.35 35.020
<i>ISO/IEC 17789:201/ ITU Y3502</i> Information technology - Cloud computing: Reference architecture	60.60	35.210
<i>ISO/IEC 19086-1:2016</i> Information technology - Cloud computing: Service-level agreement (SLA) framework, Part 1: Overview and concepts	60.60	35.210
<i>ISO/IEC DIS 19086-2</i> Information technology - Cloud computing: Service-level agreement (SLA) framework, Part 2: Metric model [UNDER DEVELOPMENT]	50.00	35.210
<i>ISO/IEC 19086-3:2017</i> Information technology - Cloud computing: Service-level agreement (SLA) framework - Part 3: Core conformance requirements	60.60	35.210
<i>ISO/IEC 19941:2017</i> Information technology - Cloud computing: Interoperability and portability	60.60	35.020 01.040.35
<i>ISO/IEC 19944:2017</i> Information technology - Cloud computing: Cloud services and devices: Data flow, data categories and data use	60.60	35.210
<i>ISO/IEC 20933:2016</i> Information technology - Distributed Application Platforms and Services (DAPS): Access systems	90.92	35.210
<i>ISO/IEC CD 22123</i> Information technology - Cloud computing: Concepts and terminology [UNDER DEVELOPMENT]	30.60	01.040.35 35.210
<i>ISO/IEC CD 22624</i> Information technology - Cloud computing: Taxonomy-based data handling for cloud services [UNDER DEVELOPMENT]	30.60	35.210
<i>ISO/IEC PDTR 22678</i> Information Technology - Cloud computing: Guidance for policy development [UNDER DEVELOPMENT]	30.20	35.210
<i>ISO/IEC AWI TS 23167</i> Information Technology - Cloud computing: Common technologies and techniques [UNDER DEVELOPMENT]	20.00	
<i>ISO/IEC PDTR 23186</i> Information technology - Cloud computing: Framework of trust for processing of multi-sourced data [UNDER DEVELOPMENT]	30.20	35.210
<i>ISO/IEC NP TR 23187</i> Information technology - Cloud computing: Interacting with cloud service partners (CSNs) [UNDER DEVELOPMENT]	10.99	
<i>ISO/IEC NP TR 23188</i> Information technology - Cloud computing: Edge computing landscape [UNDER DEVELOPMENT]	10.99	
<i>ISO/IEC NP TR 23613</i> Information technology: Cloud service metering and billing elements [UNDER DEVELOPMENT]	10.99	
<i>Source: https://www.iso.org/committee/601355/x/catalogue/p/1/u/1/w/0/d/0.</i>		

Table 2: List of ITU Recommendations on cloud computing (Series X1600 on security, Y3500 on technical aspects and Y3600 on big data)		
Number	Title	Version
X 1601	Security framework for cloud computing	10/2015
X 1602	Security requirements for software as a service application environment	05/2017
X 1603	Data security requirements for the monitoring service of cloud computing	03/2018
X 1631	Information technology, security techniques, code of practice for information security controls based on ISO/IEC 27002 for cloud services	07/2015
X 1641	Guidelines for cloud service customer data security	09/2016
X 1642	Guideline of operational security for cloud computing	03/2016
Y 3500	Overview and vocabulary	08/2014
Y 3501	Framework and high-level requirements	06/2016
Y 3502	Reference architecture	08/2014
Y 3503	Requirement for desktop as a service	05/2014
Y 3504	Functional architecture for desktop as a service	06/2016
Y 3510	Cloud computing infrastructure requirements	02/2016
Y 3511	Framework of intercloud computing	03/2014
Y 3512	Cloud computing: Functional requirements for network as a service	08/2014
Y 3513	Cloud computing: Functional requirements for infrastructure as a service	08/2014
Y 3514	Framework and requirements of trusted intercloud computing	05/2017
Y 3515	Cloud computing: Functional architecture of network as a service	07/2017
Y 3516	Cloud computing: Functional architecture of inter-cloud computing	09/2017
Y 3520	Framework for end-to-end cloud computing resource management	09/2015
Y 3521	Overview of end-to-end cloud computing management	03/2016
Y 3522	End-to-end cloud service lifecycle management requirements	09/2016
Y 3600	Big data: Cloud computing-based requirements and capabilities	11/2015
Source: https://www.itu.int/fr/ITU-T/publications/Pages/recs.aspx .		

Conclusion

Cloud computing has now matured. A significant number of services are provided in the cloud. This complicates the application of recent EU regulations (such as the General Data Protection Regulation of 27 April 2016).

For cloud service-providers, the approach through standards has the advantage of creating a common set of concepts and specifications, facilitating projects and seeing to the security of the services provided. For clients and users, it sets up a framework conducive to the transparency of offers and the exercise of the right to choose. This approach needs to be expanded to see to the comprehension, interoperability and portability of cloud services.

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