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Focus Group on Cloud Computing
Technical Report

Part 7: Cloud computing benefits from telecommunication and ICT perspectives

ITU-T

FOREWORD

The procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. The ITU-T Focus Group on Cloud Computing (FG Cloud) was established further to ITU-T TSAG agreement at its meeting in Geneva, 8-11 February 2010, followed by ITU-T study group and membership consultation.

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1. Scope

Before investigating cloud study items for ITU-T, it was proposed in the FG Cloud second meeting report, (Geneva, 2-6 September 2010), to start an output document to identify the benefits of cloud computing from the telecommunication and ICT perspectives. This Technical Report outlines cloud benefits from the telecommunication, partner and user perspectives, and identifies the general role of telecommunication players in cloud computing. This Technical Report also includes a list of candidate study items.

2. Abbreviation and acronyms

API Application Programming Interface

ASP Application Service Provider

BSS Business Support Systems

BCP Business Continuity Plan

CaaS Communication as a Service

CAPEX Capital Expense

DaaS Desktop as a Service

DDoS Distributed Denial-of-Service

GbE Gigabit Ethernet

IaaS Infrastructure as a Service

ICT Information and Communication Technology

ISP Internet Service Provider

ISV Independent Software Vendors

IT Information Technology

LAN Local Area Network

M2M Machine to Machine

OPEX Operational Expense

OSS Operational Support System

PaaS Platform as a Service

QoS Quality of Service

SaaS Software as a Service

SLA Service-Level-Agreement

SME Small and Medium Enterprises

VPN Virtual Private Network

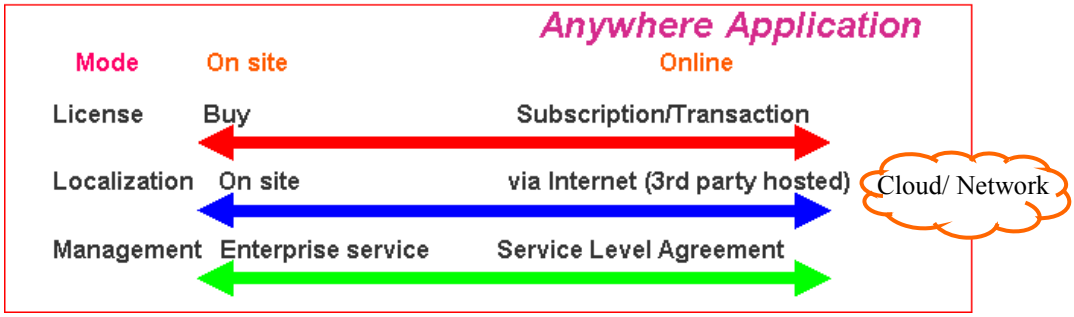
3. Cloud computing origin and evolution: from online software as a service to cloud computing

In order to identify cloud benefits from the telecommunication /ICT perspectives, we need first to understand the origin and real meaning of cloud computing.

In recent years, cloud computing has been introduced as a new approach to delivering software services over the network. During the last five years, for example, Software as a Service (SaaS) was considered as a new concept for accessing a software application (computing task) which can be described as "IT service-centric". SaaS can be defined as: a software distribution model in which applications are hosted by a service provider and made available to customers over a network, typically the Internet, and where a single instance "virtual application" of the software runs on the SaaS provider servers, following a multi-tenant 1-to-N architecture, and charged on a per-usage basis.

With SaaS, the application software is not installed on the customer's servers "on site", under the terms of a dedicated license, but as a remote "online" application, accessed through the network as a service using a simple web navigator.

A SaaS provider has some similarity with the application service provider (ASP) introduced at the beginning of 2000 as an evolution of the Internet service provider (ISP). It is, however, considered a more advanced model for managing (self-management and rapid provisioning), hosting (virtualization of resources), modular software architecture (multi-tenant API), and licensed applications instance under a usage-based transaction.



The new term *Cloud* was introduced as an emerging term to designate the "online" or "delivery through the network" characteristic of SaaS (in a telecommunication architecture diagram, the network schema is usually illustrated by a cloud). The recent development of high bit rate access and improvement in the availability of network layers by major ISPs can be considered as the most important starting point for the emerging cloud market.

Considering cloud computing as an evolution of ASP and some generalization of SaaS online services, with an extension to platform and infrastructure services (PaaS and IaaS), cloud computing can be also referred to as a new approach to implementing and delivering network computing (or Internet computing).

3. Benefits of cloud computing from telecommunication/ICT perspectives

As mentioned in the part 1 of this Technical Report, *Introduction to the cloud ecosystem*, the taxonomy of cloud services covers most of the communication and collaboration services of the telecommunication network, as well as IT resources and software applications [1].

According to this taxonomy and the recent development of the cloud computing market, cloud/network computing should be considered as an important opportunity for telecommunication/ICT players to significantly increase their share of the business ICT market currently represented by IT vendors and Internet players. Benefits of cloud computing could be considered from the different perspectives of players in the cloud ecosystem: service providers, partners, and users. The general benefits of cloud computing from telecommunication/ICT perspectives can be summarized in the following main topics:

a. To consider the cloud delivery model as a converged platform to deliver IT and communication services over any network (fixed, mobile and worldwide coverage), and used by any end-user connected devices (PC, TV, Smartphone, machines, etc.).
b. To deliver a rich set of communication services (voice and video calls, audio, video and web conferences, messaging, unified communications, content creation, workspace, broadcasting, etc.) according to a cloud multi-tenant consumption-based usage model and creating mash ups with web 2.0 collaborative services for communication as a service (CaaS).
c. To consider network services (L2-L3 connectivity, and VPN and L4-L7 network services) as smart pipes "high-grade networks" for cloud service transport and cloud interconnection (inter-cloud) in order to guarantee a secure and high performance end-to-end quality of service (QoS) for end users (considered as an important key differentiator for telecommunication players).

In addition to these benefits, some other benefits can be also considered from the service provider, partner and user perspectives, as well as improvement of security by cloud computing, as listed in the following sub-clauses [2,3].

3.1 Benefits from the service providers' perspectives

- **Cost saving**: Using cloud computing, service providers can host software at a much lower cost than enterprise customers can themselves. Virtualization and provisioning software lets them efficiently allocate computing resources, thereby lowering their cost of hardware. Cloud service providers can locate facilities at low-cost locations, provisioning which cannot be duplicated by most enterprises. There are low up-front costs. In fact, other than the costs for a user terminal (personal computer or smartphone), web browser, and network capacity for each end-user, there are no software or hardware costs that customers need to pay.
- **Improve total cost of ownership and de-risk**: Investments are shifted from the upfront capital expense (CapEx) to operational expense (OpEx) for consuming IT resources. Increases capacity utilization of IT assets. User terminals, servers, or software, which are not needed in-house (onsite), can be offered up for outsourcing (online), and equipment not fully utilized can be used jointly with third parties to reduce idle time. Costs can also be reduced by short lead times, and by paying for just what is needed.
- **Highly scalable and flexible infrastructure**: A massively scalable engine allows building highly scalable services for users and partners and an infrastructure scale to meet the demand for peak loads and seasonal variations.
- **Efficiency and flexibility of resource management:** Service providers can use more flexible and efficient resources (IT resources, server, storage and network resources) by using virtualization technology in cloud computing.
- **Business agility with rapid service deployment**: Service provision with lower cost through the efficient use and management of resources. The easier and faster a provider can

perform an administrative task, the more expediently the business moves, reducing costs or driving revenue. Easier-to-get IT operations established and less need for IT expertise at the company level. Service providers also find their speed of deployment is much quicker than if they were to build applications, or worse, a whole data center, from scratch.

- **Reliability of service with high availability**: Since the workloads can be spread across many facilities, and even across clouds, redundant instances of applications can be used to avoid downtime and increase the availability. In addition, data distribution strategies can help address disaster (e.g., earthquake, tsunami, flooding, hurricane, typhoon) recovery and business continuity issues.
- **High support of third-party business**: An intermediate service provider utilizes a marketplace which allows multiple input from independent software vendors among ISV, developers, cloud-service SaaS providers, integrators, business customers, and end users
- **Energy efficiency**: In principle, cloud computing can be an inherently energy-efficient technology for ICT, provided that its potential for significant energy savings that have so far focused on hardware aspects, can be fully explored with respect to system operation and networking aspects.
- **IT capability:** Service providers can establish large-scale, on-demand, flexible, scalable IT capability by low-cost cloud technology to provide IaaS, and analyze operation data and information processing.
- **Unified managed based OSS:** Service providers can build a unified cloud system to upgrade the level of system response, reduce cost, and increase the speed in providing new services.
- **Accelerate service innovation:** Service providers can set up an application service hosting platform, integrated with telecommunication services and network capability, to accelerate service innovation, especially for mobile internet services.
- **Capability aggregation:** Service providers can utilize the cloud platform to aggregate capability (the third party's and their own), integrate the industry chain and enhance customer loyalty.

3.2 Benefits from partners' perspectives

Partners of cloud service providers include: network providers, software providers (virtualization software, distributed middleware, and other new core software), equipment providers, system integrators, and consulting service providers.

The benefits for these partners are as follows:

- **Network provider:**
  - From providing simple network access to integrated service transformation products upgrades to bringing new business growth
  - Users to increase their dependence on access, improve access bandwidth and overall access to income
- **Software provider:**
  - mainstream software providers of solutions are extensions of the existing services in rich at the same time, their product line brings new revenue growth.
- **Equipment provider:**
  - new hardware upgrades for equipments such as servers, storage, network, and related equipment procurement, will increase. This requires equipment providers to

strengthen technical reserves and research in the area of cloud computing, and to provide complete systems support to cloud service providers.

- **System integrator:**
  - the need for system integration solutions for cloud service providers will open up new markets for system integrators.

3.3 Benefits from users' perspectives

- **Optimized and rapid provisioning**: This allows for immediate provision of the most recent services over the networks. This also provides multiple users with the optimal application software for each industry or business process, or easy use of the whole system, including the hardware, by other users.
- **Anywhere application with any device**: Services may be used by anyone able to get online with any devices, not only desktop but also mobile device, meaning that this can support users with service-level mobility and business can be carried out anywhere in the world.
- **Pay-per-use pricing**: Cloud computing eliminates the significant up-front expenditures required to purchase and maintain hardware. Companies only pay for the capacity that they are utilizing. Utility providers price their services on a pay-as-you-go model, similar to the subscription-based pricing of on-demand companies
- **Low migration costs**: If customers are dissatisfied, it is relatively easy for them to switch to a competing solution by signing a new contract, transferring data, and retraining users. This is in stark contrast to customers of on-premise solutions, who tend to have a substantial investment in their customer system and are loathe to pay new license fees or to undergo another lengthy implementation.
- **Secure important data**: Cloud computing enables the user to more easily backup and store important data in multiple sites and to continue its business, even immediately after the occurrence of a disaster (e.g., earthquake, tsunami, flooding, hurricane, typhoon).

3.4 Improvements of security by cloud computing

- **Resource concentration:** concentration of resources has the obvious advantage of cheaper physical parameterization and physical access control (per unit resource) and the easier and cheaper application of a comprehensive security policy and control over data management, patch management, incident management, and maintenance processes.
- **Rapid scaling of protection resources:** A service provider has the potential to dynamically reallocate resources for filtering, traffic shaping, encryption, etc, in order to increase support for countermeasures (e.g., against DDoS attacks) when an attack is likely or it is taking place.
- **Ease security service administration:** Large service providers can offer a standardized and open interface to Managed Security Services that providers offer services to all its customers. This potentially creates a more open and readily available market for security services where customers can switch providers more easily and with lower set-up costs.
- **Effective and efficient check and update:** end user virtual machine images and software modules can be updated with the latest patches and security settings according to fine-tuned processes. They are also more likely to be regularly updated and patched in a centralized fashion minimizing the surface of vulnerability.

- **Audit and sample-gathering:** In the event of a suspected security breach, the user can take an image of a live virtual machine for offline forensic analysis, leading to less down-time for analysis. With storage on tap, multiple clones can be created and analysis activities parallelized to reduce investigation time.

4. Roles of telecommunications in cloud computing

Telecommunication/ICT players have an important role to play in the emerging Cloud market and ecosystem. Telecommunication network is a central part for multitenant cloud architecture delivering multi-services for multi-users with high QoS and optimal resource allocation. This role is considered as a unique position to deliver high-grade clouds services integrating services, platform, data center and IP network infrastructure with guaranteed end to end SLA. The roles of Telecommunication/ICT players in cloud computing are considered from both operational and technical aspects.

The main telecommunication operational roles are listed below:

a. Network control: this is considered as the main driver for cloud services delivery, telecommunication/ICT have a high level of expertise's in the deployment and end to end SLA management of all public and private network services (L1 up to L7) and data centers.
b. Operation and maintenance: this includes customer support, fulfillment assurance and billing (OSS/BSS) for large scale of regional and worldwide networks of 100 millions of subscribers.
c. User experience and customer relationship: telecommunication/ICT players have developed a good user experience for consumer, SME and large enterprise markets.
d. Trusted partner: telecommunication/ICT players are considered as a trusted partner for customer with high level of reputation for data security, integrity, and privacy with a local presence. Most of telecommunication/ICT players have implemented several ICT standards (from ISO and ITU-T), guidance and frameworks (ITSMF and TMF).
e. Cloud Intermediary: this allows the control the delivery of a holistic IT, Network and Communication cloud services for inter-cloud or private-public cloud federation.

Various telecommunication technical roles have also been analysed and categorized into five types:

1. **High speed transport technology which allows stress-free access to the cloud computing service**
    - Technology applicable is either in-house transport (e.g., LAN) access transport or the wide area network.

    Related standard development organization and fora: IEEE802.3ba (40/100 GbE), MEF, ITU-T SG15, IETF, etc.
2. **Network technology which enables virtualization and scale-out feature of cloud computing**
    - transport level virtualization

    Related standard development organization and fora: IETF, ITU-T SG13
    - network design and network management to allow on-demand and elastic resource assignment

    Related standard development organization and fora: ITU-T SG2, TM Forum, DMTF, etc.
    - encryption techniques and security measures applicable to virtualized system

Related standard organization and fora: ITU-T SG17, ISO/IEC JTC1 SC27, etc.

3. **Technology which enables eco-friendly cloud computing**
   - green cloud data centre

   Related standard development organization and fora: ITU-T SG5 WP3, code of conduct of EU, etc.
   - power saving techniques for internet

   Related standard organization and fora: IETF, ITU-T SG15, 3GPP etc.
   - real-time monitoring and automatic control which enable optimum load balancing or
   - task allocation
   - sensor network

   Related standard organization and fora: 3GPP, ETSI M2M, ITU-T SG13, etc.
4. **New networking technology where cloud computing will be applicable, e.g., network which automatically collect mass sensor information.**

   Related standard organization and fora: 3GPP, ETSI M2M, ITU-T SG13, etc.
5. **Use of cloud computing by service provider for the speedy and flexible application development, e.g., as a service platform for smartphone with LTE.**

   Related standard development organizations and fora: ITU-T SG13 (NGN-SIDE), etc., ITU-T SG9, SG16 (video content distribution)

The above categorization may not necessarily be exhaustive.

5. Proposal for candidate study items on cloud computing for ITU-T

According to the cloud benefits and value propositions listed in the previous sections, the following list of candidate study items are proposed in three categories, A though C:

A. Items are investigated within FG Cloud and output documents are produced as an input for further development by ITU-T SGs.

1. **Cloud ecosystem:**
   - Telecommunication-centric use cases of a cloud ecosystem (from the perspective of cloud service providers, cloud service partners, and cloud service users, and from the inter-cloud perspective)
   - General requirements: basic requirements for cloud services and for key business roles in a cloud ecosystem, and main capabilities of a cloud ecosystem
   - Business deployment scenarios in a cloud ecosystem, according to different actors' participation in the ecosystem and the business roles played by them
   - Providing of multi-tenancy guidelines and general framework of customizability and optimality for the cloud platform and shared-resource infrastructure.
2. **Cloud security:**
   - Security architecture/model and framework
   - Security management and audit technology
   - Business continuity plan (BCP)/disaster recovery
   - Storage security
   - Data and privacy protection

- Account/identity management
- Network monitoring and incident response
- Network security management
- Interoperability and portability security
- Virtualization security
- Obligatory predicates

3. **Cloud functional reference architecture:**
   - Standards to guarantee reference architecture for design build and run for cloud services and resources, and to avoid vertical vendor solutions lock-in (services, platform and infrastructure)
   - Resource orchestration: close to resources carrying vendor-specific customization
   - Services orchestration: agnostic to vendors and resources supporting service composition
4. **Cloud infrastructure :** as defined in the Part 4 of this Technical Report
   - General requirements and framework of cloud infrastructure
   - Functional requirements for computing capability
   - Functional requirement for the cloud network
   - Functional requirements & architecture for storage capability
   - Functional requirements for resource management
   - Power management
5. **Inter-cloud: Procedures and interfaces are required for:**
   - policy negotiation among multiple clouds based on the Service Level Agreement (SLA) of each provider
   - discovering available cloud resources among multiple clouds
   - reserving, leasing and releasing cloud resources among multiple clouds
   - dynamically connecting interworking clouds via networks
   - dynamically switching over and switching back end-user access

B. Items are partly investigated within FG cloud and output documents are produced as an input for further development by ITU-T SGs

6. **Desktop as a services (DaaS):**
   - Use cases based on virtual desktop service, corresponding requirements and DaaS-specific functionalities
   - Virtual desktop delivery protocol to display and control virtual desktops running on a remote server (Starting by requirements and gap analysis of existing protocols)
   - Real-time compression adaptation for DaaS to support seamless high quality video in limited network bandwidth environment
   - Virtual desktop allocation mechanism including management of on-demand applications on various operating systems and their assignment to a proper virtual machine
   - Users' client interface to support virtual desktop service regardless of their various device types

7. **Cloud management (resources and services):**
   - Flexibility for BSS & OSS
   - Real-time provisioning and on demand usage activation,
   - Self-service management, metering, charging and operation policy
   - Federation
   - SLAs, configuration and lifecycle management.
   - Metrics for SLA and Quality control mechanisms
   - Availability and redundancy
   - Monitoring function such as Network monitoring and bottle-neck detection

C. Items are introduced within FG Cloud with a limited investigation

8. **Accessibility and eco-friendly cloud computing**

   - Eco-friendly cloud:

     Data centre for cloud computing

     Power-saving techniques

     Real-time monitoring and control for load allocation to minimize power consumption
   - Accessibility and cloud computing

     Accessibility for poorer and emerging countries, with multi-language support

     Access for old persons with age-related disabilities and persons with disabilities

     Access Anywhere from public and private places (home, school, library, enterprise, hospitality, etc.,) anytime and from any connected devices (fixed, mobile, TV, etc.)

     Rapid access to secure cloud services with lower CapEx

     Friendly user and rich web browser access interface

A proposal for initiating a standard activity within ITU-T can be:

Categories	C	B	A
Candidate study items	**8**	**6, 7**	**1*, 2*, 3*, 4, 5**

* It is recommended to develop this work item in collaboration with ISO/IEC JTC1, according to Recommendation ITU-T A23.

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