



Cloud Computing in Education and Research

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Outline

- **Challenges in Education and Research**
- **SaaS, PaaS and IaaS for Education and Research**
- **Benefits, risks and barriers of CC**
- **Guidelines for selection and deployment of CC**
- **Success stories of Cloud deployment in Arabic Countries**
- **Case study: Sfax University**



Challenges in Education and Research

- **Higher cost of IT resources**

- The need for IT resources and services are drastically growing
- Managers and technical staff mainly host their IT services (compute, storage, software, collaboration tools...) on premises.
- They allocate **important budget** and time to perform complex management operations

Challenge: *Budget restrictions, shrinking revenues and limited funds for research and development*



Challenges in Education and Research

- **Lack of efficiency**
 - Teachers, students, researchers and faculty members
 - require technical skills to set up the experimental environment
 - focus the effort on peripheral tasks more related to system administration than to the course topics.
- **Challenge:** Lack of concentration on the “core business” of education and research.



Challenges in Education and Research

- **Emergence of new communication, collaboration and mobile platforms**
 - **Bring Your Own Device (BYOD)**
 - Students increasingly come to schools and universities with their own mobile devices
 - Access to course content and educational services from anywhere and at anytime.
 - **Collaboration and communication tools**
 - Faculty members increasingly rely on multimedia, **communication and collaboration services**



Challenge: Traditional educational services and models can not meet these requirements

Challenges in Education and Research

- **Virtual learning environments**
 - Interactive Multimedia Learning Environments
 - Distance Learning platforms, Moodle...
 - MOOC – Massive Open Online Courses

Challenge: Important compute resources are required for media (video, voice, ...) processing, broadcasting, storing and analysis.



Cloud Computing solution



SaaS for Higher Education and Research

- SaaS is a software distribution model in which applications are hosted by a service provider and made available to customers over the Internet.
 - Example: Google Apps, Microsoft Office 365



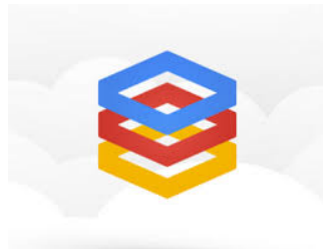
PaaS for Researchers

- PaaS offers services to help developers throughout the whole life cycle of an application, from design to test and production.



IaaS for Education and Research

- Provides students, researchers and teachers the ability to provision processing, storage, networks where the consumer is able to deploy and run software, which can include OS and applications



IaaS Services: Three types

- IaaS-hosted Virtual Server
 - **Server virtualization**
 - Research sector and Business Workflow
- IaaS-hosted Virtual Desktop
 - **Desktop virtualization**
 - Higher Education sector
- IaaS-hosted Storage
 - **Storage virtualization**
 - Education and Research sectors

IaaS-hosted Virtual Desktops

- Private IaaS

- VDI (Virtual Desktop Infrastructure)

- Products: VMware Horizon, XenDesktop, Microsoft VDI, Oracle VDI, CloVER...



- Public IaaS

- DaaS (Desktop as a Service)

- Cloud providers:

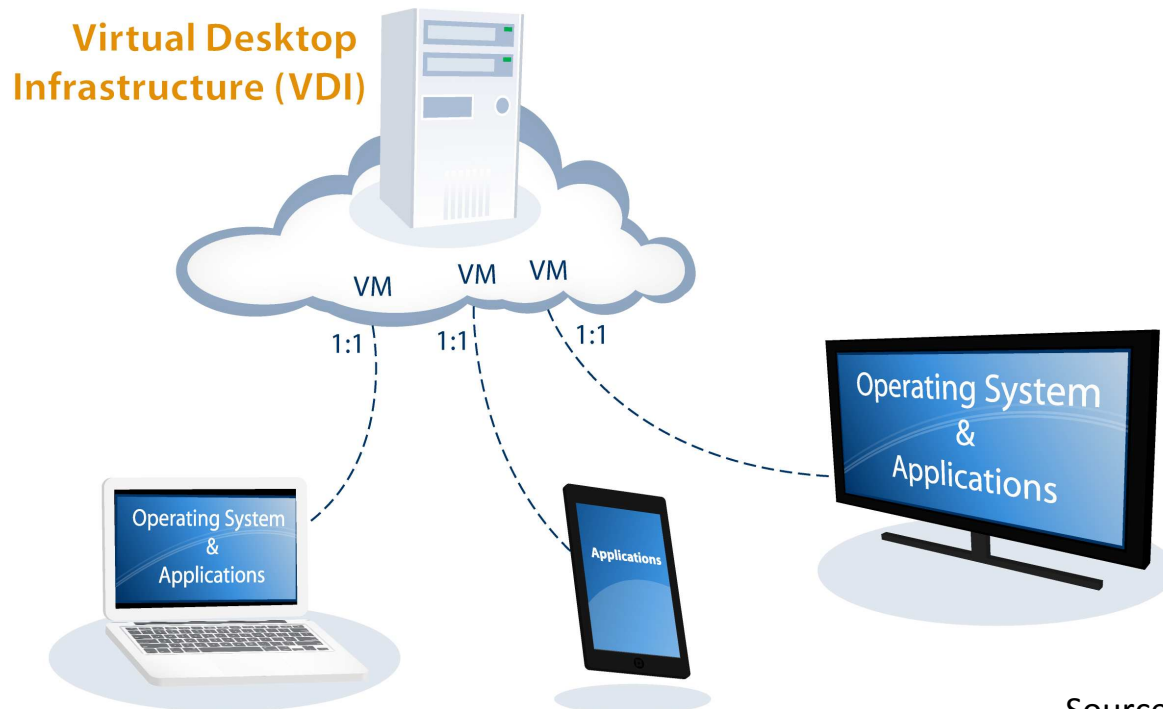
- Deskton and Amazon WorkSpaces



Virtual Desktop Infrastructure (VDI)

- “A desktop-centric service that hosts user desktop environments on remote servers, which are accessed over a network using a remote display protocol.”

Wikipedia



Benefits of Cloud Computing for Education and Research



- **Agility and Elasticity**

- Allow educational institutions to begin with small resources and services without significant financial investment and gradually build them up.
- Cloud ensures elasticity and eliminates the time needed for purchasing and deploying additional infrastructure.
- Administrators can increase agility by automating management and provisioning of cloud-based services to simplify operations while reducing costs.

Benefits of Cloud Computing for Education and Research



- **Enhanced availability**

- Teachers and students increasingly demand online services for learning and assessment like LMS, Collaboration tools. These services must be highly available
- Cloud ensures high availability for the hosted educational services where any unplanned outage can be devastating and unacceptable.
- Students do not have to worry about backing up or losing data as it should be safely stored in the cloud (using for instance redundancy).
- Data must be accessible from anywhere and using any device (smartphone, mobile phone..).

Benefits of Cloud Computing for Education and Research



- **Increased Efficiency**

- Teachers and faculty members would be able to concentrate on their core business of education and research.
- Cloud allows them to be more productive and efficient since they will focus on their core activities (course assessment, experimental environment set up...) rather than wasting time on peripheral tasks related to system and networking management.
- Faculty members can quickly deploy applications that deliver coursework and lectures and offer interactive learning without considering infrastructure and system management complexity.

Benefits of Cloud Computing for Education and Research



- **Reduced Cost**

- Virtualization and Cloud paradigms enable educational service delivery at a lower cost than traditional infrastructures.
- The "pay as you go" characteristic of public cloud allows educational institutions to decrease cost and shrink revenue and investment.
- Both public and private clouds reduce hardware and software maintenance, capacity issues and other daily functions that are time-consuming and costly.
- Several public cloud providers (like Google and Microsoft) offer the latest educational tools, features and services for free (office suite, chat, mailing ...).

Benefits of Cloud Computing for Education and Research



- **Energy efficiency**

- Reduce energy consumption and save money by taking advantage of built-in power management feature of CC including performance optimizations, idle resource utilization and advanced power management of cloud servers.
- Educational institutions can reduce their own electricity consumption and promote green computing in their countries.

- **Enhanced Security**

- Cloud security functionalities help IT managers of education institutions to enhance security and to reduce risk using consistent security policies and enforcement rules and up-to-date threat intelligence.

Risks and Barriers to Adoption

- **Security and Trust**
 - Data privacy: users do not have control or know where their data is being stored.
 - The data protection laws in some countries restrict the transfer of personal data to other particular countries.
- **Centralization**
 - Centralized data center management can certainly add another risk to cloud computing. If the compute or storage servers go down, all supported services and data are affected.
- **Network Dependency**
 - Cloud access is dependent on the Internet availability.
- **Vendor lock-in**
 - Lack of interoperability: Major actors offer solutions that are platform-dependent with proprietary software or hardware.

Guidelines for selection and deployment of cloud services

- **Functionality**
 - Specify the required functionalities including mailing, storage, interoperability and level of integration of existing platforms within a product suite.
- **Technical issues**
 - Related to some management operations including user account authentication, usage monitoring, workflow process migration, integration of existing services...
 - Evaluate technical challenges that must be addressed when moving to a cloud environment (Infrastructure upgrade, staff skills, networking and security audit...)
- **Contract**
 - Study the contract to be established with the cloud provider.
 - Examine the initial term of the contract, penalties, SLA, support, maintenance cost,....
- **Training and User experience**

Success stories of Cloud deployment in some Arabic countries

- **King Abdulaziz University (Saudi Arabia)**
- **King Saud University (Saudi Arabia)**
- **Jordan University of Science and Technology**
- **Qatar Cloud Computing Center (Qatar) National**
- **School of Engineers of Sfax - Sfax University (Tunisia)**
- **ESPRIT School (Tunisia)**

Use case: Sfax University

- **Objective:** set up a private IaaS cloud that offers
 - Virtual Servers
 - all applications and services already deployed in physical servers are now hosted by virtual servers running on the cloud
 - Storage as a service
 - storage capacities are offered on demand to students and faculty members to store, backup and share documents, courses and databases.
 - Virtual Desktops
 - The ENIS School has replaced traditional PCs with cloud based VDI solutions.
 - 10 classrooms are equipped with 30 thin clients connected via a local area network to a private cloud.

VDI for Virtual Computing Classrooms

Before



After



Thin Clients



Cloud
Computing

ENIS Cloud Infrastructure

- **Hardware**

- 4 servers acting as controller nodes (redundancy mode)
- 8 servers for computing
 - 5 servers reserved for VDI offering virtual desktops
 - 3 servers hosting virtual servers
 - XEON Processor, 6 cores, 2.4 Ghz, 128 Go RAM
- Storage server: 40 To SAS
- Programmable Switch Node (10 Gbit/s)



- **Software**

- Hypervisor: KVM and Hyper-V (MS)
- Cloud Manager: OpenStack
 - an open source solution offering private cloud deployment
- CloVER VDI
 - an OpenStack appliance offering VDI capabilities over the cloud infrastructure.

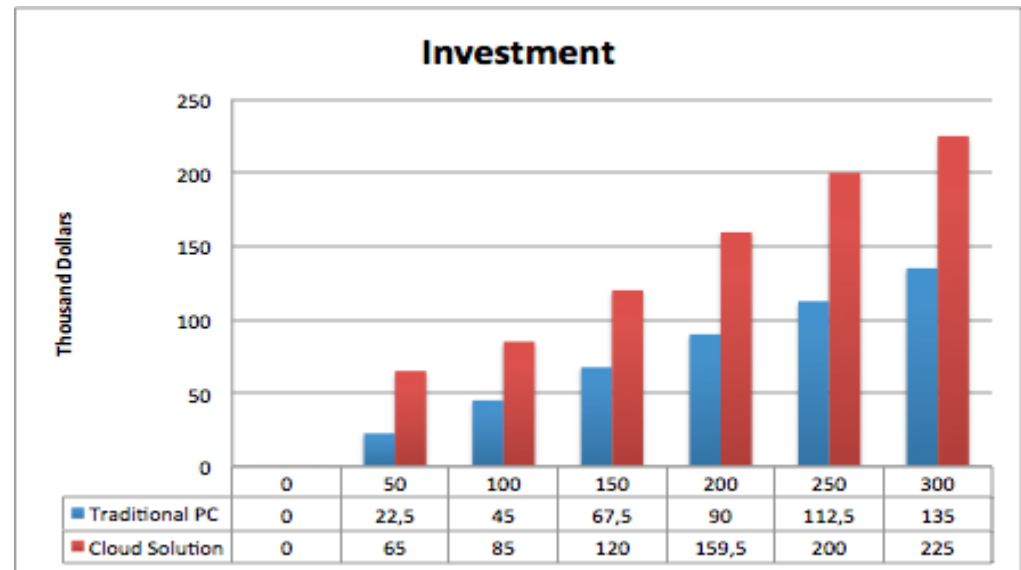


- **The VDI servers offer 300 virtual desktops for students.**

03/12/14 — Each one is composed of 2 Go RAM and 10 Go of storage.

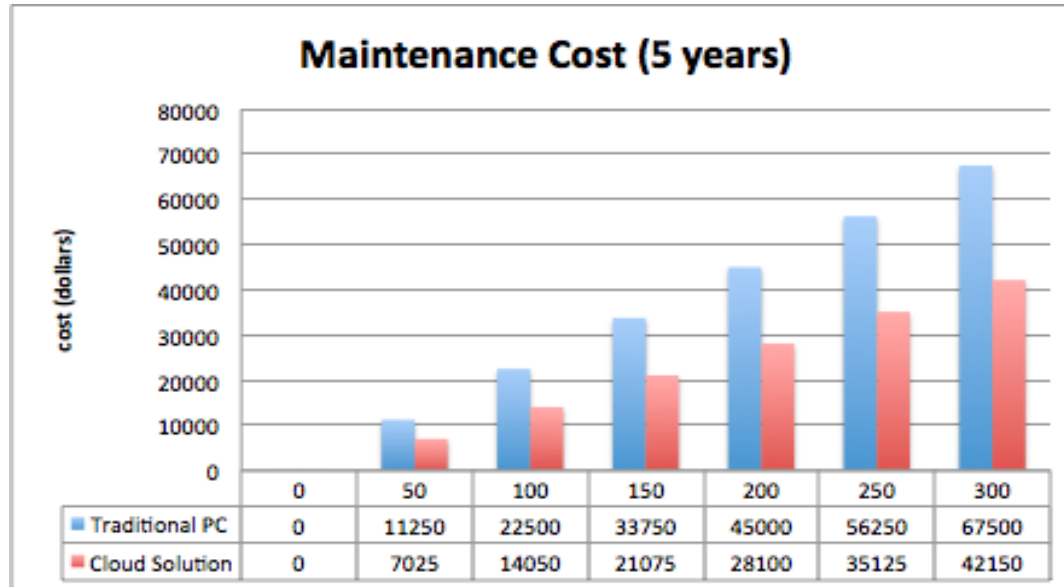
Initial Investment

- Cloud composed of
 - thin clients (250 \$ per unit)
 - servers (10.000 \$ per unit).
- The initial investment (around 225.000\$) required to set up a cloud offering 300 virtual desktops is higher compared to the total price of 300 physical computers (around 135.000\$).



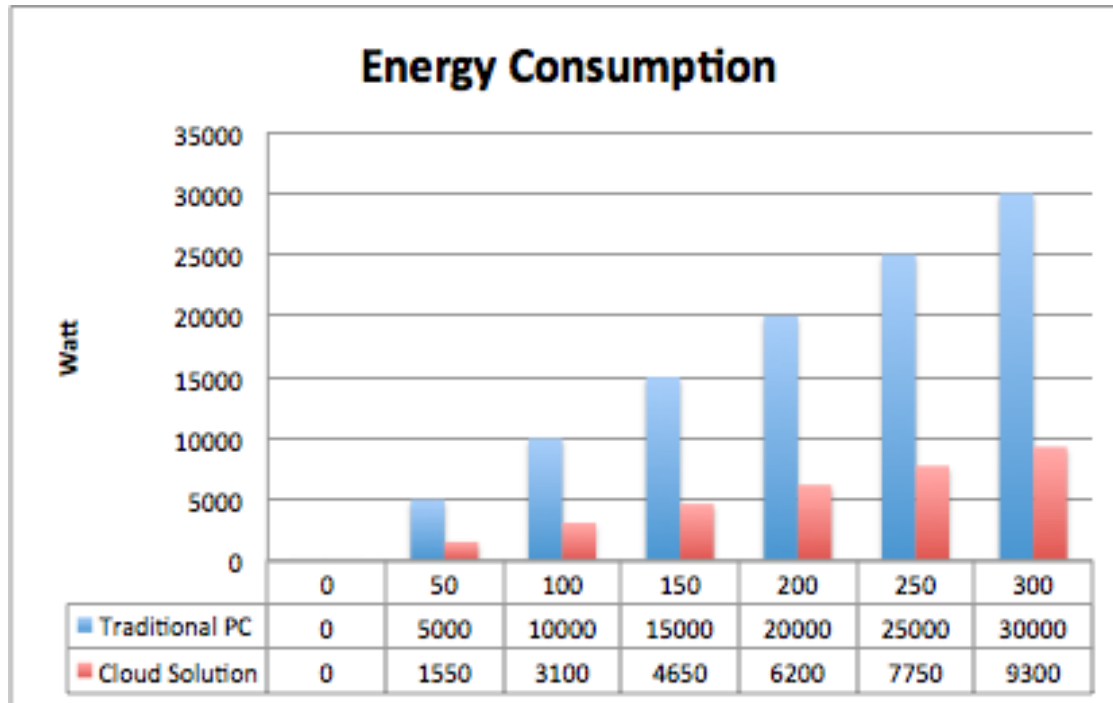
- Although the capital invested in the cloud is higher than that invested in traditional PC platform, an estimation of the Return on investment (ROI) over 5 years shows the gain and efficiency of the cloud solution.

Maintenance Cost



- Annual software and hardware maintenance cost is assumed to be
 - 10% for traditional PC
 - 5% for Thin Client
 - 14% for server
- **Cloud can reduce maintenance costs of around 40%**

Energy Consumption



- Thin clients consume an average of 7 watts compared to a 100 watt PC.
- The average energy consumption of a server: 1200 watt
- **Cloud can significantly reduces energy consumption to almost 70%.**

Conclusions

- **In the next five years, institutions of education expect to cut 20 percent of their IT budget by moving applications to the cloud**
- **To support a smooth transition, organizations must first develop a comprehensive strategy that addresses the challenges unique to each institution.**
- **Hybrid cloud: where an organization might use a public cloud for some functions (basic business applications) and their private cloud for others (storage for personnel data that is very sensitive).**

