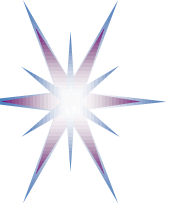


Professional Education on Cloud Computing

Technology and Services Engineering

Yuri Demchenko
University of Amsterdam

CloudCom SCC-Computing Summer Symposium
21 June 2013, UiS, Stavanger

Outline

- Cloud Computing Common Body of Knowledge (CBK)
- Course instructional approach: Bloom's Taxonomy and Andragogy
- Course structure and mapping to general Cloud Services Model (CSM)
- Testbed, hands in and labs
- Practical realisation – University of Amsterdam
- Next steps and discussion

Common Body of Knowledge (CBK) in Cloud Computing

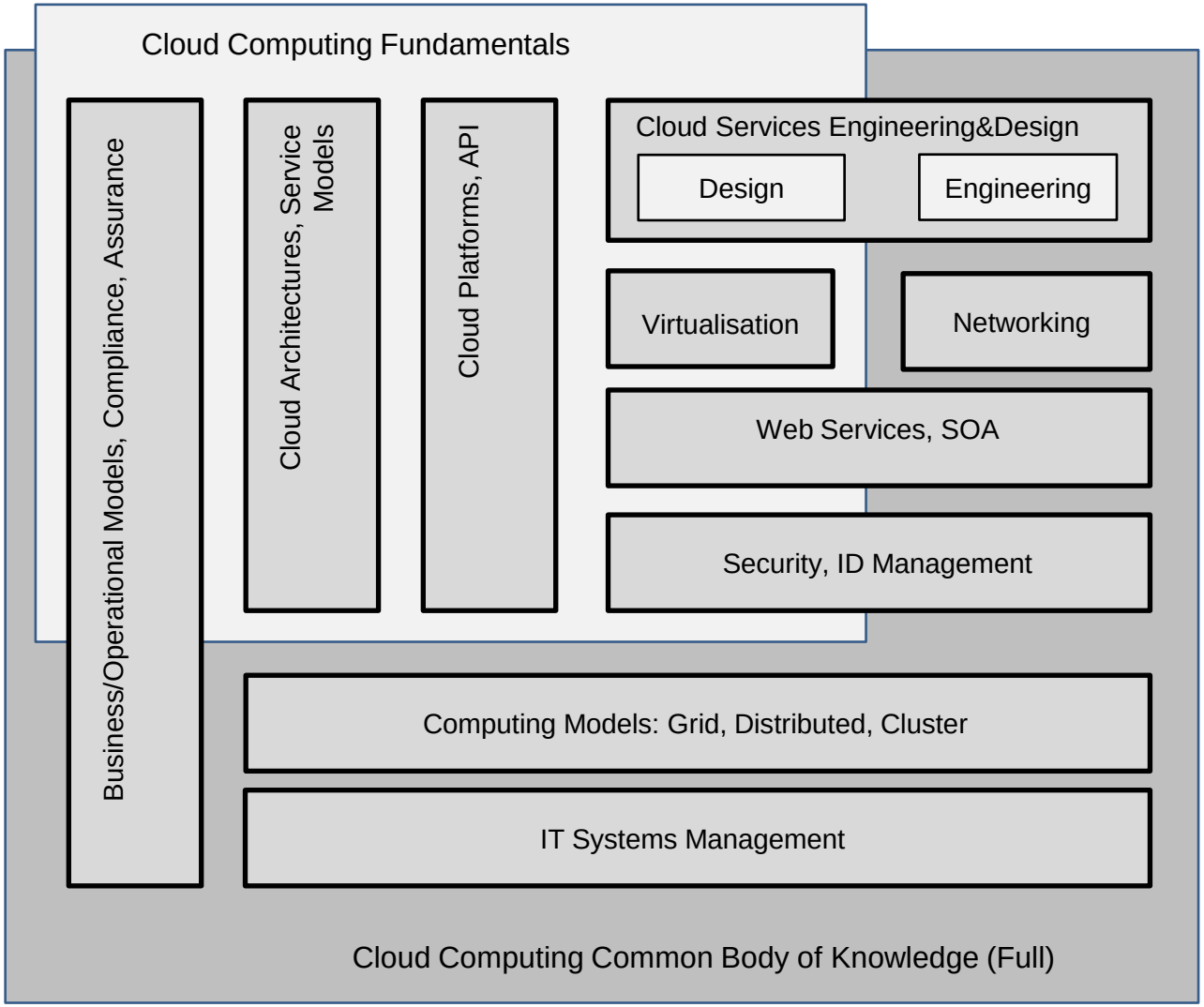
CBK refers to several domains or operational categories into which Cloud Computing theory and practices breaks down

- Still in development but already piloted by some companies, including industry certification program (e.g. IBM, AWS?)

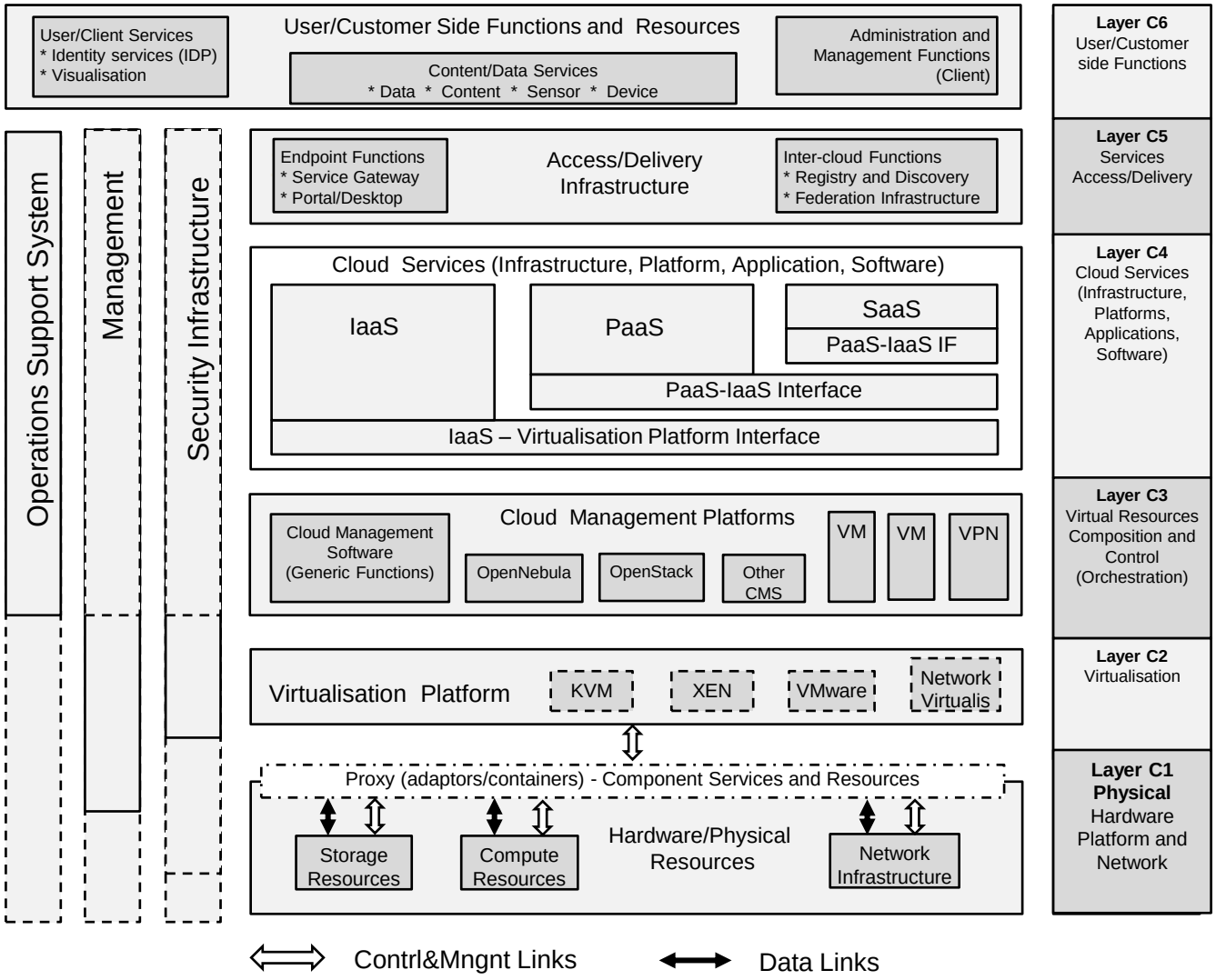
CBK Cloud Computing elements

1. ***Cloud Computing Architectures, service and deployment models***
2. ***Cloud Computing platforms, software/middleware and API's***
3. ***Cloud Services Engineering, Cloud aware Services Design***
4. Virtualisation technologies (Compute, Storage, Network)
5. Computer Networks, Software Defined Networks (SDN)
6. Service Computing, Web Services and Service Oriented Architecture (SOA)
7. Computing models: Grid, Distributed, Cluster Computing
8. Security Architecture and Models, Operational Security
9. IT Service Management, Business Continuity Planning (BCP)
10. Business and Operational Models, Compliance, Assurance, Certification

CKB-Cloud Components Landscape



Multilayer Cloud Services Model (CSM) – Taxonomy of Existing Cloud Architecture Models



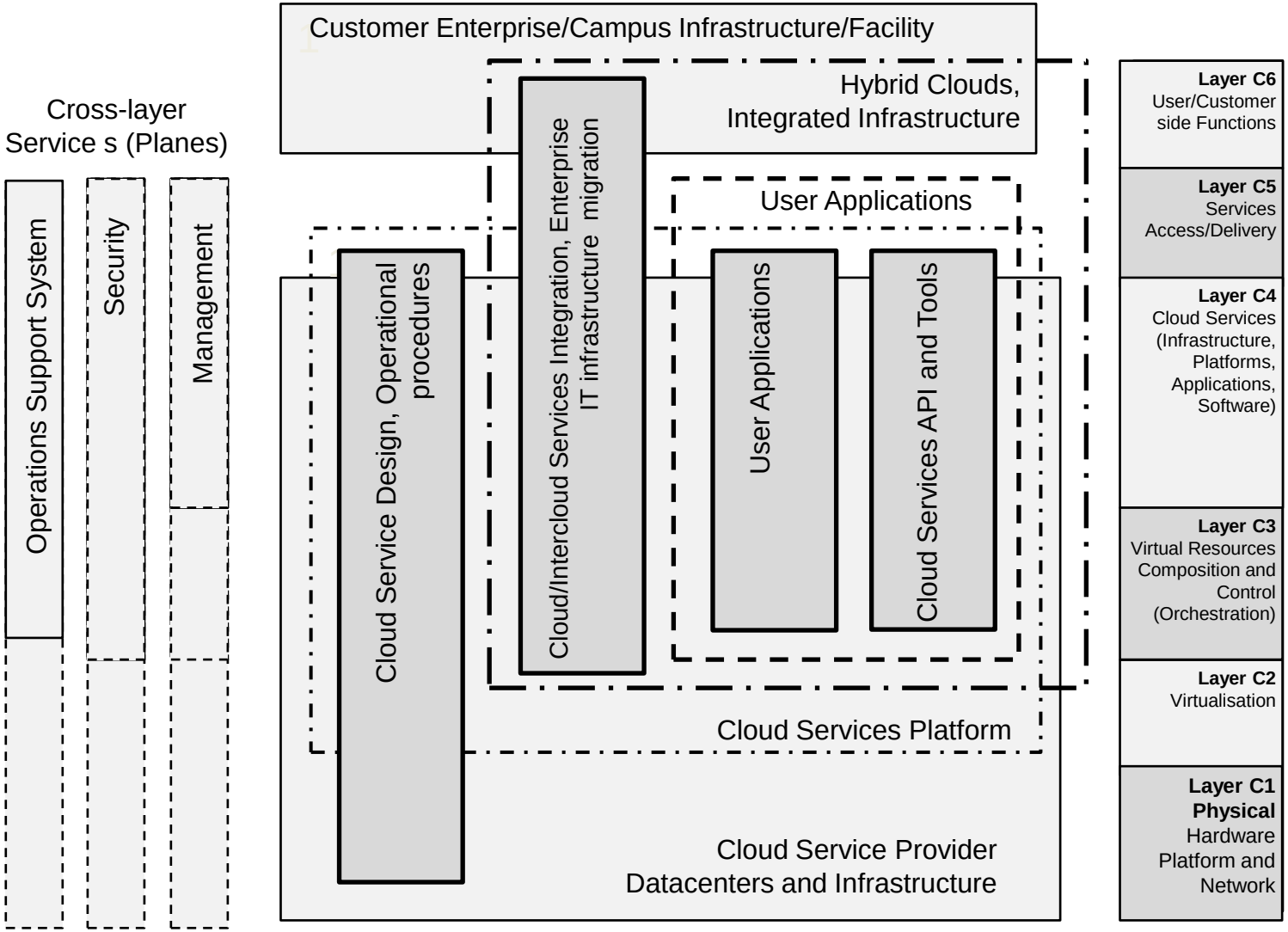
CSM layers

(C6) User/Customer side Functions
(C5) Services Access/Delivery
(C4) Cloud Services (Infrastructure, Platform, Applications)
(C3) Virtual Resources Composition and Orchestration
(C2) Virtualisation Layer
(C1) Hardware platform and dedicated network infrastructure

Control/ Mngnt Links

Data Links

Relations Course Components and CSM



Professional Knowledge in Cloud Computing

- Professional level of knowledge (general) includes but not limited to
  - Knowing basic concepts and major application areas
  - Knowing similar concepts (and concepts inter-relation) and alternatives, as well as application specific areas
  - Knowing basic technologies and their relation to basic concepts
  - Knowing authoritative (and not authoritative) sources of information and how to evaluate quality of information
    - Ability to work with standards (what is not an easy source of information)
    - Ability to critically evaluate and filter some inconsistent information, e.g. popular sites like wikipedia and similar, blogs, etc.
    - Critically evaluate vendors' information which is sometimes biased and/or doesn't provide enough background information
- Cloud computing is a new technology but it is becoming a common preferred base/platform for all current and future developments
- Becoming an expert in Cloud Computing
  - General professional knowledge and understanding of the main development areas
  - Practical development and experience with few projects, writing reports, technical documents, *following and contributing to standardisation*
  - Cloud aware and cloud powered analysis and thinking

Professional Education in Cloud Computing - Principles

- Provide knowledge both in **Cloud Computing** as a new technology and **background technologies**
- Empower the future professionals with ability to **develop new knowledge** and build stronger expertise, prepare basis for new **emerging technologies** such as **Big Data**
- **Bloom's Taxonomy** as a basis for defining learning targets and modules outcome
  - Provides a basis for knowledge testing and certification
- **Andragogy vs Pedagogy** as instructional methodology for professional education and training
  - Course format: On-campus education and training, online courses, self-study

Bloom's Taxonomy – Cognitive Activities

Knowledge

Exhibit memory of previously learned materials by recalling facts, terms, basic concepts and answers

- Knowledge of specifics - terminology, specific facts
- Knowledge of ways and means of dealing with specifics - conventions, trends and sequences, classifications and categories, criteria, methodology
- Knowledge of the universals and abstractions in a field - principles and generalizations, theories and structures
- **Questions like: What are the main benefits of outsourcing company's IT services to cloud?**

Comprehension

Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, describing, and stating the main ideas

- Translation, Interpretation, Extrapolation
- **Questions like: Compare the business and operational models of private clouds and hybrid clouds.**

Application

Using new knowledge. Solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way

- **Questions like: Which cloud service model is best suited for medium size software development company, and why?**

Analysis

Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations

- Analysis of elements, relationships, organizational principles
- **Questions like: What cloud services are needed to support typical business processes of a web trading company? Give suggestions how these services can be implemented with PaaS or IaaS clouds. Provide references to support your statements.**

Synthesis

Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions

- Production of a unique communication, a plan, or proposed set of operations, derivation of a set of abstract relations
- **Questions like: Describe the main steps and tasks for migrating IT services of an example company to clouds? What services and data can be moved to clouds and which will remain at the enterprise premises.**

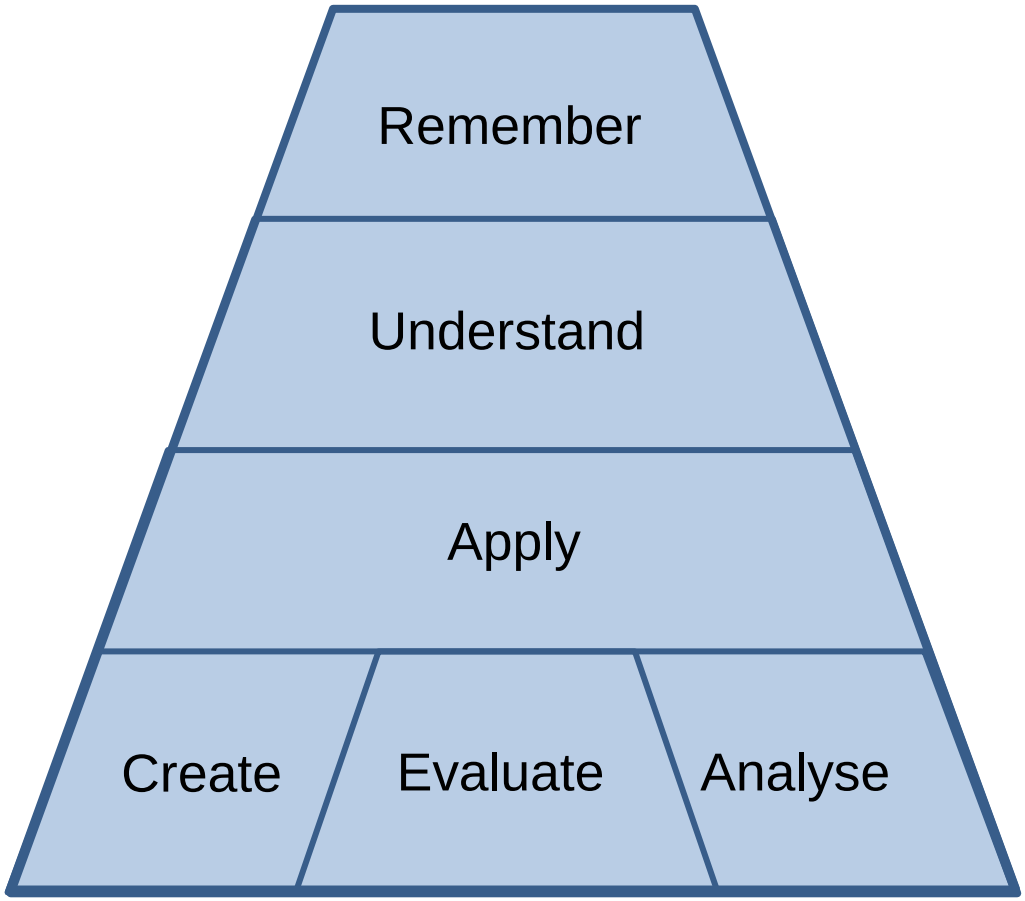
Evaluation

Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria

- Judgments in terms of internal evidence or external criteria
- **Questions like: Do you think that cloudification of the enterprise infrastructure creates benefits for enterprises, short term and long term?**

Mapping Bloom's Taxonomy from Cognitive Domain to Professional Activity Domain

- Perform standard tasks, use API and Guidelines
- Create own complex applications using standard API (simple engineering)
- Integrate different systems/components, e.g. Cloud provider and enterprise (complex engineering)
- Extend existing services, design new services
- Develop new architecture and models, platforms and infrastructures



Mapping Course Components, Cloud Professional Activity and Bloom's Taxonomy

Taxonomy Cognitive Domain [3]	Taxonomy Professional Activity Domain
Knowledge	Perform standard tasks, use standard API and Guidelines
Comprehension	Create own complex applications using standard API (simple engineering)
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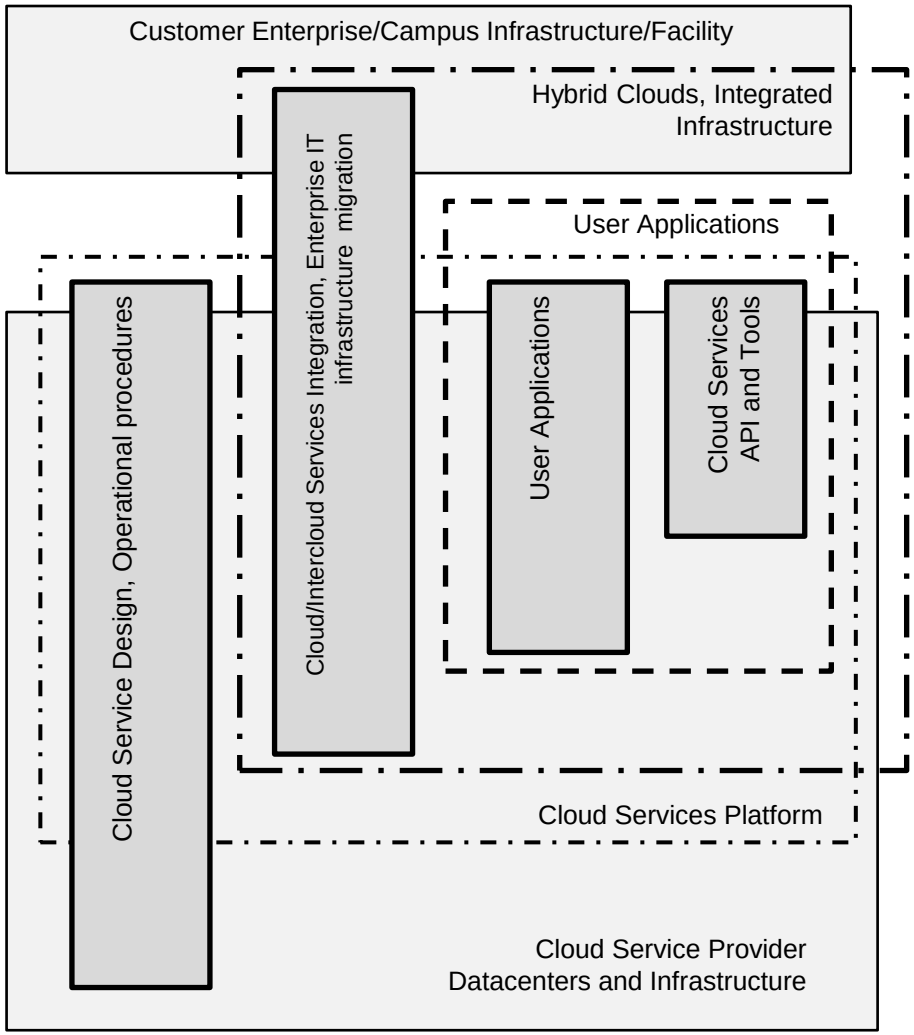
Evaluation	



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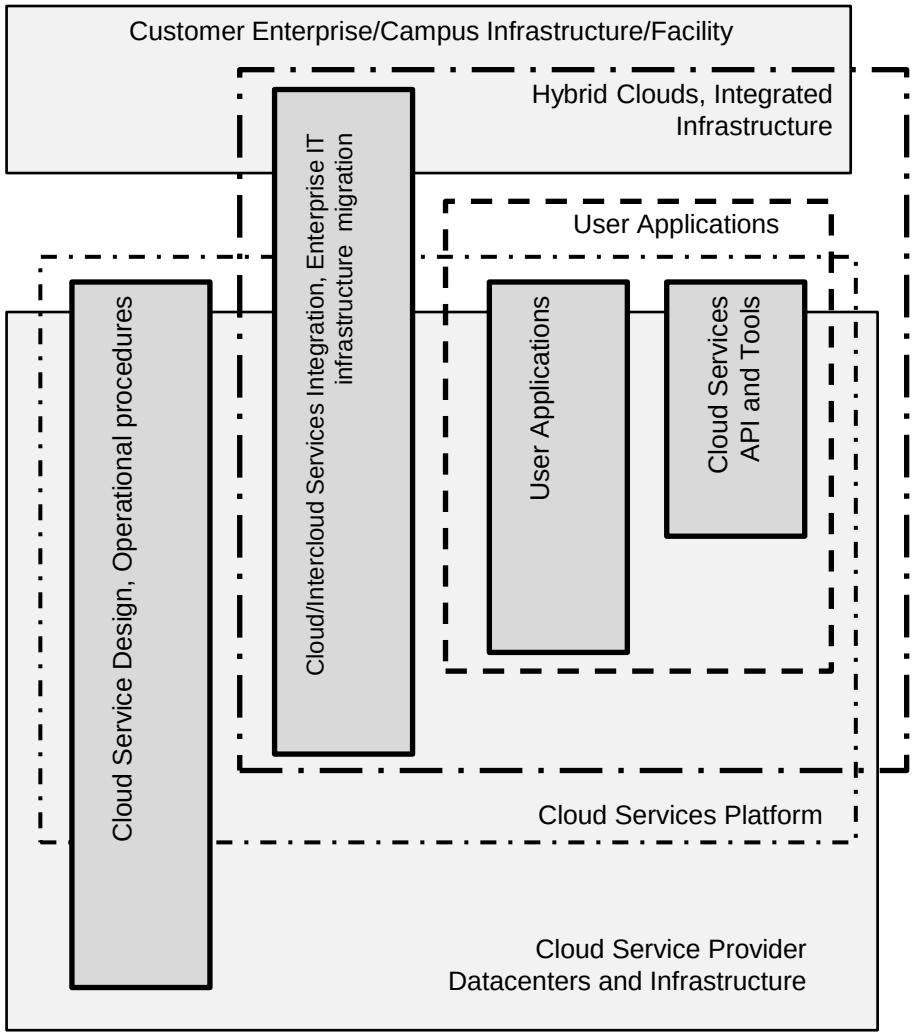

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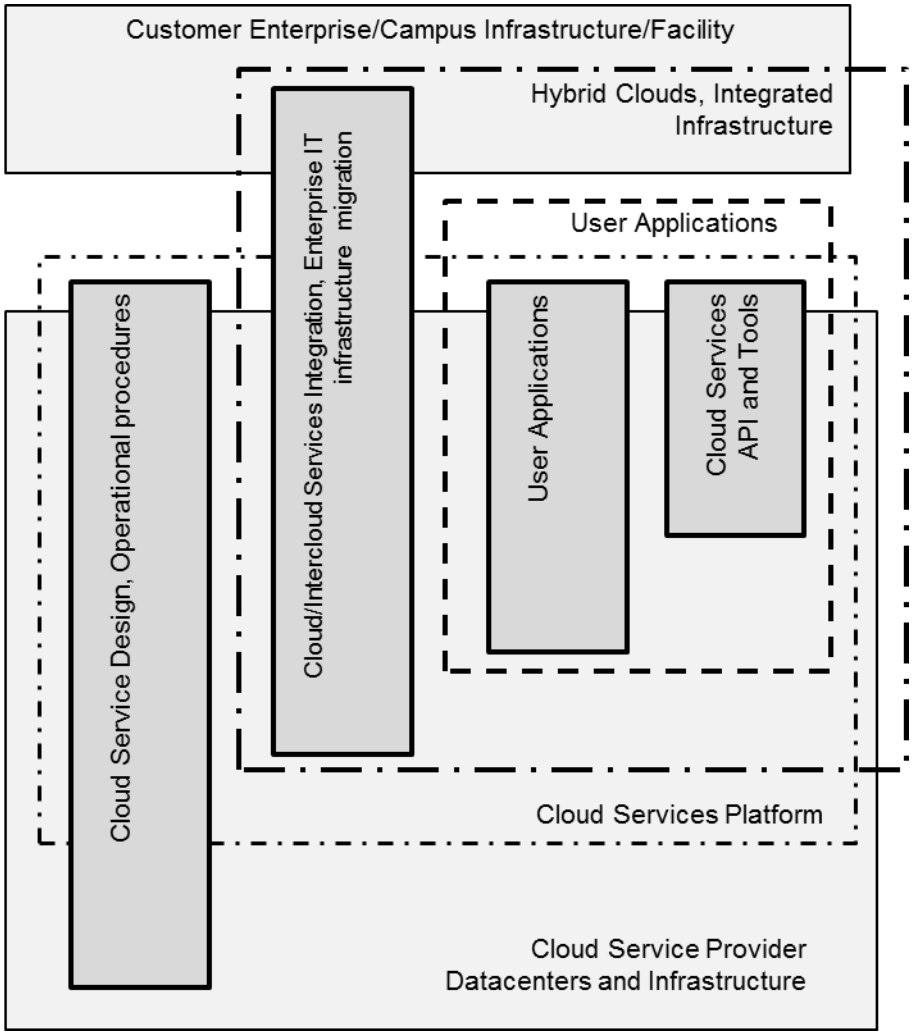

Pedagogy vs Andragogy

Pedagogy (child-leading) and Andragogy (man-leading)

- **On-campus and on-line education**
- Developed by American educator Malcolm Knowles, stated with six assumptions related to motivation of adult learning:
  - Adults need to know the reason for learning something (Need to Know)
  - Experience (including error) provides the basis for learning activities (Foundation)
  - Adults need to be responsible for their decisions on education; involvement in the planning and evaluation of their instruction (Self-concept)
  - Adults are most interested in learning subjects having immediate relevance to their work and/or personal lives (Readiness).
  - Adult learning is problem-centered rather than content-oriented (Orientation)
  - Adults respond better to internal versus external motivators (Motivation)

Applying Andragogy to Self-Education and Online Training - Problems

- Andragogy concept is widely used in on-line education but
  - Based on active discussion activities guided/moderated by instructor/moderator
  - Combined with the Bloom's taxonomy
- Self-education (guided) and online training specifics
  - Course consistency in sense of style, presentation/graphics, etc
  - Requires the course workflow to be maximum automated
    - Especially if coupled with certification or pre-certification
  - Less time to be devoted by trainee
    - Estimated 1 hour per lesson, maximum 3 lessons per topic
  - Knowledge control questionnaires at the end of lessons or topics

Proposed Cloud Computing Course Structure

Basic parts & Advanced parts

Part 1.1. Cloud Computing definition and general usecases

Part 1.2. Cloud Computing and enabling technologies

Part 2.1. Cloud Architecture models and industry standardisation: Architectures overview

Part 2.2. Cloud Architecture models and industry standardisation: Standard interfaces

Part 3.1. Major cloud provider platforms: Amazon AWS, Microsoft Azure, GoogleApps, etc

Part 3.2. Major cloud provider platforms: Public, Research and Community Clouds

Part 4. Cloud middleware platforms: Architecture, platforms (OpenStack, OpenNebula), API, usage examples

Part 5.1. Cloud Infrastructure as a Service (IaaS): Architecture, platform and providers

Part 5.2. Cloud Infrastructure as a Service (IaaS): IaaS services design and management

Part 6.1. Cloud Platform as a Service (PaaS): Architecture, platform and providers

Part 6.2. Cloud Platform as a Service (PaaS): PaaS services design and management

Part 7.1. Security issues and practices in clouds

Part 7.2. Security services design in clouds; security models and Identity management

Part 8 (Advanced). InterCloud Architecture Framework (ICAF) for Interoperability and Integration: Architecture definition and design patterns

Target Audience

- Basic profile ("essentials" or “fundamentals”) is for IT decision makers, informed users:
  - all concepts are explained, clouds opportunities are demonstrated, general use cases are analysed, examples of use are provided
  - general security issues in clouds are explained
  - intended the course will allow this group of listeners to be able to understand what they need to learn more.
- "Advanced" part is for engineers/practitioners developing cloud services, and doing integration/consulting work:
  - different cloud architectures are explained, details on the different cloud related open interfaces (like CDMI, OVF, OCCI) and proprietary API (like Amazon AWS API) are provided, detailed overview of popular cloud platform/middleware (like OpenStack, OpenNebula, Eucalyptus) is provided
  - security models (including main cloud providers) and technologies explained, federated cloud identity and access control is explained
  - provide advice/suggestions where to look for further information

Cloud Testbed to Support Education - Concept

- Support education course on clouds and cloud based, e.g. Big Data, SDN (Software Defined Networks)
  - Basis for hands-in assignments and labs
- Support other courses/labs than can be modeled/simulated using interconnected VMs infrastructure
  - E.g., network technologies, web design, etc.
- Can be easily and fast setup for the course semester and suspended after finishing course
  - Platform independence
  - Should also allow replication/burst to e.g. Amazon EC2 or other cloud platforms
  - May require some peripheral devices, network switches, also remote sites

Practical Realisation – University of Amsterdam

- Prototype tested as Short Cloud Technologies lecture course in Hong Kong Polytechnic University – 21-22 November 2012
  - Motivated to approach more conceptually
- Part of Computer Science and Software Engineering Master
  - Options: Colloquium (3-4 lectures); Summer course; Online self-training
- Duration: 8 week (6 credits)
  - Starts January 2013
  - 3-4 guest lectures
- Content
  - Lectures: Papers review; Research Topics; Hands-in/Labs (Cloud lab, Amazon, Azure(?)) and mini-project
- Knowledge control and Grading
  - Weekly questions (multiple choice; tricky)
  - Exam (TBD)
  - Research topics report and feedback

Research Topics (discussion topics)

- Free selection of 32 proposed topics
  - Twin topics covering main research problems in Cloud Computing
  - Initial description (orientation) and choice of recommended papers
    - 3-4 papers need to be found by students
  - For group of 2 students
- Presentations and discussion (on week 4 & week 8)
  - Short summary submitted a week before
  - Feedback before presentation (short) and after presentation

Next steps and beyond clouds

- Create online professional training course on Cloud Computing
- Development of the curricula on Data Intensive Science and Technologies
  - Define technology and Common Body of Knowledge (CBK)
    - Reuse Cloud Computing curricula experience
- Contributing to the Research Data Alliance (RDA)
  - BoF on Education and Training in Data Intensive Science and Technologies at RDA1 meeting 18-20 March 2013 (Gothenborg)
  - Next RDA meeting and BoF 15-17 September 2013 (Washington)
  - Prospective Working Group @RDA and intension to submit a project proposal to H2020 (special fiche #7 in Data/Sci Infrastructure section)
- NIST Big Data Working Group http://bigdatawg.nist.gov/home.php
  - Kickoff call next Wednesday 26 June 2013 19:00-21:00 (CET)

Discussion and FAQ

- Will MOOC change need for professional in-campus education?
- Lectures vs Projects hands-on & Collaborative learning in groups
- Any other?