European Polytechnical University

E-learning Platform
Technological architecture

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1 Technological LMS architecture

1.1. *Technological infrastructure (platform)*

The technological system and network architecture, designed according to criteria of maximum flexibility and scalability, guarantees high performance of access and use of services by several simultaneous users. In particular, the following are guaranteed:

- a maximum number of 40,000 concurrent users;

- an average number of 15,000 concurrent users;

- response times optimized by QoS (Quality of Service) systems.

The system also has the following features:

- single sign-on access and unique identification system, with the assignment of permissions on the system based on your user profile (teachers, tutors, students, etc.);

- personal data management and modification system;

- virtual classroom for the management of synchronous events (chat, videochat, videoconference), which can be used both for the tutoring of lessons and for the use of conferences, meetings and seminars;

- provision of asynchronous communication services, such as forums, mailboxes, bulletin boards, FAQs, online diary and community;

- provision of educational content in the form of Learning Objects in XML format (eXtensible Markup Language) according to the international ADL SCORM standard;

- ability to track the delivery of educational content for educational and certification purposes, with granularity up to the level of Learning Objects, according to the international ADL SCORM standard;

- highly interactive WEB system for the delivery of courses and services, for the transmission of semantically advanced contents;

- ability to track in real time the use of the distance course in terms of delivery and use of all the contents up to the level of Learning Objects, both for the support of the didactic model chosen, and as regards the protection of the copyright of the teaching materials;

- aggregation and sequencing of educational content, even at the level of high granularity, adaptive and customizable in real time;

- ability to provide and track specific points of verification of learning, with recording, up to the passing of the exam, of all the verification points characterizing the training course provided;

- ability to track all delivery times with high granularity, at the level of atomic teaching units (SCO, Shearable Content Object);

- historical archiving capacity of the final results, which can be evaluated in the process of assigning university credits;

- ability to report the traced data both to the teacher / tutor and to the student, in compliance with the law on privacy and in order to allow explicit self-certification of the times and processes for providing training and verification contents;

- ability to author with indexing of contents, aggregation with variable granularity, rules of adaptability expressed in explicit form and interoperable between systems of various suppliers;

- online storage capacity with the possibility of access authentication and standard metadata sharing protocols (SOAP XML);

- possibility to publish specialized application profiles for each course, university or consortium of universities, according to the international specifications IMS Global Learning Consortium;

- possibility to carry out administrative activities online (enrollment in the course, booking exams, etc.);

- accessibility also to particular categories of users (such as the disabled), through a graphic interface designed in compliance with the WCAG 1.0 guidelines of the World Wide Web Consortium (W3C).

A detailed description of the technical characteristics of the platform and the minimum requirements is available on the University website.

1.2. *Technological standards*

The University guarantees the compliance of the platform with the following international standards:

- AICC, Aviation Industry CBT Committee, is an open forum of professional teachers with the common goal of establishing guidelines relating to the technology used for interactive, online and offline learning. Further information is available at http://www.aicc.org.

- IMS is a consortium of institutions and companies that operate in the training sector and together develop and promote specifications regarding online learning to facilitate the exchange of information between heterogeneous Learning Management Systems. More information can be found on the IMS website, http://www.imsproject.com.

- IMS QTI (Question and Test Interoperability) for creating tests and evaluations. It is possible to create Test Collections containing various questions in the form of true / false, single or multiple choices, filling of text fields, with the possibility of formatting the texts in HTML. Tests or surveys can collect questions by taking them statically or dynamically (randomly) from Test Collections, and it is possible to define various characteristics for them: time limits, scores and passing thresholds, maximum number of attempts. The application also supports the delivery of tests for certification on products or services, for example allowing the resumption of the test in case of forced abandonment by the candidate or the possibility to dynamically increase the time remaining for the completion of the test in cases exceptional.

- SCORM (Sharable Content Object Reference Model) defines specifications that aim to incorporate the work of AICC, IMS and IEEE into a single standard. It is a registered trademark of ADL (Advanced Distributed Network - http://www.adlnet.com).

- HTML5 for the use of content on both desktop and mobile platforms.

1.3. *Hardware architecture*

The platform is based on a hardware configuration aimed at achieving the best levels of reliability, scalability and efficiency.

All services are monitored 365/7/24 through automatic systems capable of detecting minimal malfunctions. If an alarm state is detected, the anomaly situation is reported to the technicians on call who will profile the fault and start a solution through extremely tested escalation procedures and methods.

The infrastructure was rated among the most reliable among the 50 in the world monitored by the British analyst Necraft. To date it is consistently among the top 10 positions for reliability.

1.4. *Amazon Web Services (AWS)*

For the hardware architecture, the technologies offered by Amazon Web Services are used to improve the delivery, load balancing and performance of the entire information system of the group.

Amazon Web Services, in fact, offers reliable and scalable cloud computing services. These services operate in 12 geographic regions into which Amazon itself has divided the globe. The service used to improve the delivery of content is CloudFront. When an end user requests content delivered with CloudFront, they are routed to the edge location that offers the lowest latency, enabling content delivery at maximum performance levels. If the content is already in that edge location, CloudFront delivers it immediately. If the content is not in the edge location, CloudFront retrieves it from an Amazon S3 bucket or HTTP server (e.g. a web server) identified as the source of the final version of the content.

Amazon CloudFront is a global content delivery network (CDN) or content delivery network (CDN) that enables delivery of data, video, applications, and APIs to users with minimal latency and high throughput. CloudFront integrates with AWS services, including physical locations directly connected to the AWS global infrastructure and optimized software such as AWS Shield for DDoS mitigation, Amazon S3, Elastic Load Balancing, and Amazon EC2 as application data sources, and Lambda @ Edge for executing custom code in the region where users are located.

This service allows us to use a global Content Delivery Network that allows users to enjoy the contents scattered in different locations, in order to always guarantee fast and reliable access. The University uses traffic equal to 150 TB per month distributed over all the planned regions.

1.5. *Hardware architecture on AWS*

These are the technologies used in detail:

- **Route 53**: DNS management of the various systems
- **AWS WAF**: firewall for data protection
- **ELB (Elastic Load Balancer)**: load balancing based on service requests
- **EC2**: web server management
- **RDS**: platform data management
- **DynamoDB**: tracking management
- **IAM** AWS Identity and Access Management: controlled access to resources

For systems security, WAF is used as a web firewall to block cross-site scripting and sql injection. Also, by analyzing the logs through Athena.

There is also a periodic and constant control with consequent action aimed at blocking IPs that make abnormal requests.

IAM is used to ensure the management of resources through applications. By doing so, through access control, we are able to allow the limitation of permissions and access to resources, increasing the security of the entire system. Furthermore, for the files requested by users, we use a security system via signedUrl with a custom policy that allows us to establish the availability of the requested resource only for a certain period.

ELB is used both to have greater availability and scalability of applications and to have greater tolerance for any faults.

There have been no accidents in the past 12 months. The University has advanced backup systems, both locally and Amazon server management, which allow us to restore systems, data and infrastructures necessary for the provision of services in the face of any emergencies that affect their regular activity.

Amazon's load balancer (ELB) allows a service that is always accessible and fluid without slowing down. Amazon's ECS Elastic Container Service for increasing resources in the event of overload. The combination of ELB and ECS allows complete availability of services without interruption for the end customer..

1.6. *Multimedia content management*
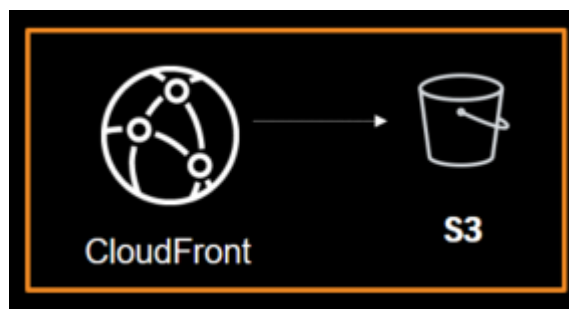
The use of multimedia content is managed through S3 and CloudFront, which guarantee adequate performance both from the point of view of management by the operators (Ease of Use) and from the point of view of the performance perceived by the end user: times reduced response associated with high performance.

1.7. *Support for students with disabilities*

Distance training, due to the particularity of the training model (absence of on-site attendance obligations, educational supports in electronic format, support from teachers and tutors via telephone / fax / e-mail, possibility of completing all bureaucratic procedures at a distance, possibility of taking the on-going tests remotely) offers an opportunity of extreme importance for students with disabilities, precisely because of the absence of spatial and temporal constraints and for the possibility of resorting to the use of new technologies for the use of educational services.

In providing its services, the University pays particular attention to ensuring ease of access for students with disabilities.

It also offers a service of identification and acquisition of computer aids (hardware and software) that facilitate the disabled student in the use of computers, in order to enhance communication in situations of verbal, visual and graph-motor difficulties. In this context, the University follows the guidelines of the World Wide Web Consortium (W3C) and their adoption in Italy, with reference, specifically to the Italian legislative framework, to the activities of the Authority and the Presidency of the Council of Ministers (W3C member).

The University from a careful assessment of the needs of services by students is working on the enhancement of the technological infrastructure with a view to integrated information management.

The platform provides for the integration of two areas closely related to the student's career: the administrative-accounting one and the one related to the student's educational curriculum.

In particular, the student will have the possibility to access the administrative-accounting data where the details regarding the payments of university fees will be reported, also having the possibility of printing the relative payment receipts and the possibility of communicating any notes concerning the accounting aspects.

A further opportunity given to the student will be to be able to follow their teaching career by viewing the status of their expected courses in terms of profit results and also in this case having the opportunity to print certificates for free use.

Finally, there is a section purely dedicated to the final exam (preparation and delivery of the thesis) which allows the tracking and management of the graduation procedure between the learner and the teacher starting from the request for assignment of the discipline up to the drafting of the final paper that it will flow into an area specifically created and used by the students as well as the teachers and the Headmasters where it will be possible to view the relative documents with appropriate credentials.

1.8.   *Minimum requirements for using the platform and compatibility*

The platform offers maximum compatibility with both fixed and mobile systems. The video lessons follow the HTML5 standard.

For optimal viewing of video content, a browser with the following characteristics is therefore recommended (among the most used):

Explorer	Firefox	Safari	Chrome	Opera	Edge
9.0+	3.5+	4.0+	5.0+	10.5+	all

The platform is fully compatible, in terms of structure, layout and graphic organization, with mobile devices, such as tablets and smartphones.

Continuous testing has been carried out on Android and Apple platforms, as regards mobile devices, on Windows, Unix and Apple systems as regards fixed devices.

The versions under examination were, specifically:

- Android 5 and later, with native browser, Firefox and Chrome
- iOS 8 and later with Safari and Chrome
- Internet Exlorer 9.0+
- Mozilla Firefox 3.5+
- Safari 4.0+
- Google Chrome 5.0+
- Opera 10.5+
- Microsoft Edge all versions

As far as video streaming is concerned, it is guaranteed thanks to the consolidated compatibility of the mp4 format with all the major web browsers in circulation.