Teaching and Research Project. Candidate for Tenure-eligible Lecturer. Public competition Number: 81 - Place: 7.

Candidature presented by **Jordi Mateo Fornés** to apply for the lecturer position **no. 81, place 7** of the area of knowledge of Architecture and Technology of Computers, of the Department of Informatics and Industrial Engineering (DIEI) of the Higher Polytechnical School (Campus Igualada), in the studies of Degree in Digital Interaction and Computing Techniques of the University of Lleida. Published in the *BOE n. Núm. 8261 published 2/11/2020*.

Contents

1 Teaching project

1.1 Background

Nowadays, the candidate is a post-doctoral member at the University of Lleida (**UdL**). He is member of the teaching staff in the Grau en Tècniques d'Interacció Digital i de Computació (**GTIDIC**) at Igualada Campus. He belongs to the Computer Science Department (**DIEI**) and concretely to the Distributed Computation Group (**GCD**). He received the B.Sc and M.S in computer engineering degrees from the Higher Polytechnical School (**EPS**) of the Universitat de Lleida in 2012 and 2013, respectively. He also holds a PhD, Cum Laude, in Computer Science / Cloud services by the University of Lleida (2019).

The candidate started working as a full-time professor at UdL where he was responsible, with a total of *18 ECTS*, for the three subjects associated to the position of this call: **Operating Systems, Applications for Mobile Devices and Systems Administration and Virtualization**. Furthermore, the candidate designed the degree curriculum for these subjects and all the respective course materials.

The main teaching area of the candidate is **Operating Systems**. He has lectured three years (*3 ECTS per year*) (2015-2016, 2016-2017, 207-2018) as a teacher assistant in the Grau en Enginyeria Informàtica at the University of Lleida. Since course 2019-2020 he is coordinating and lecturing (*6 ECTS per year*) in the GTIDIC.

The candidate also has experience teaching in topics related to the knowledge area associated to the department holding this call such as: High-Performace Computing (MPI or OpenMP) or Systems security. He taught the **High-Performance Computing** course in the Master of Computer Science (UdL, 2018-2019). Furthermore, he led two sessions of a post-graduate course (CyberSecurity, 2019, UdL), one session about security at the Operating System level and another about security in the cloud.

Since the course 19/20 to the actuality, the candidate is also responsible for (*6 ECTS per year*) for **Innovation in ICT** course. Additionally, only in the course 19/20, he also taught, coordinated and designed the degree and the course material of the **Computing Techniques** course (*6 ECTS*).

During these academic years, the candidate has developed course materials and has applied innovative teaching methodologies and providing high quality teaching. The results can be verified in the students' opinion surveys (results provided in the CV), and in the good academic results of the students.

The candidate has also participated in the committees of several degree's and master's thesis. He has also directed and co-directed several undergraduate students and he is currently co-directing two PhD thesis.

1.2 Teaching Objectives

The main objective in the teaching field is to train students with the appropriate rigor and level of depth so that they acquire the necessary qualification, so that they can successfully develop their professional future and to transfer knowledge to society.

Specific objectives include:

- Promote all kinds of creativity as a prominent tool to achieve innovation.
- Accompany students in the process of abstraction and reflection to manage complex things.
- Develop the students' skills and competencies that allow them to make decisions with autonomy and responsibility in the work and social environment.
- Work with the students the methodical rigor with which they have to approach the objectives set, teaching content, but at the same time work methodologies and problem-solving techniques and decision making.
- Develop programming philosophies about the capacity to analyze a situation, identify its key components, model the data and processes, and create or refine a program to solve the problem.
- Promote teamwork and active participation in the different activities carried out in the classroom or through the virtual campus, through interaction with students and interaction between students.
- Promote a lifestyle of learning to learn, not giving up and fighting for dreams.
- Establish good communication with students, both group and individually, promoting human relationships.
- As a teacher, adopt a role of learning facilitator, subject content organizer, professional counsellor, and supervisor of student learning and work.

1.3 Common Methodology

The teacher promotes during all the courses the collective metacognitive reflection methodology to assess learning, where the students at the end of the teaching sessions or the challenges need to answer themselves: What have I learned today? How did I learn that? What has allowed me to improve? Why did it help me? Why can it serve me?

1. **Theory sessions**: In these sessions, the theoretical contents of the subject are introduced and to the students, and also practical implications are discussed with them.
2. **Asynchronous sessions**: In these sessions, an active methodology is used, where the students are the protagonist by performing and looking for solutions to different challenges proposed by the teacher and used to go a step further from the theoretical contents.
3. **Practical sessions**: A social learning methodology will be used with live-coding sessions, where (teacher and students) together read, interpret and implement code fragments.
4. **Self-employment**: A cooperative methodology based on challenges will be used, where students in groups need to apply the knowledge acquired in the theoretical and practical sessions and research for external information to solve the challenges proposed by the professor. The design and resolution of the challenges must be presented and discussed with other groups using oral presentations.

1.4 Content of teaching proposal

Based on the teaching objectives indicated, it is appropriate to make a proposal for teaching content for the subjects **Operating Systems**, **Applications for Mobile Devices**, and **Systems Administration and Virtualization**, specified in the announcement of the call for applicants. For the planning of the subjects, the Higher Polytechnic School has adopted the model of teaching guides set by the University of Lleida, which defines general information, academic objectives, significant competencies, fundamental contents, methodological axes, development plan, evaluation system and bibliography. The candidate has prepared the teaching guides of the aforementioned subjects1 for the 19/20 and 20/21 academic years. Complete information about the courses for the course 20/21 can be obtained from official syllabus and course guides, see:

- **Operating Systems**: `https://guiadocent.udl.cat/pdf/en/102377`.
- **Applications for Mobile Devices**: `https://guiadocent.udl.cat/pdf/en/102386`.
- **Administration and Virtualization**: `https://guiadocent.udl.cat/pdf/en/102378`.

1.4.1 Operating Systems

This subject of Operating Systems is taught in the second year of the GTIDIC of the University of Lleida. It is part of the compulsory module.

This course will introduce students to modern operating systems. Operating systems are the brain that makes modern computers work. Kernels abstract the features provided by computer hardware, making those features safer and more convenient to use. Therefore, designers, programmers and system administrators need to understand how hardware works (at least at the level of specifications) and how software works. Them must become comfortable with navigating /reading/modifing kernel files written in C language.

In this course, we will focus on UNIX-based operating systems. Over the course, we will analyze in detail each of the major components of an operating system (from kernel to user, from user to kernel and also both from kernel to hardware and from hardware to kernel). Students will explore the Linux kernel, the process and memory management. Furthermore, another important skill when professionals work with OS is task automatization. During the course, students will learn shell scripting to seek these automatitzations.

Subject contents

- Topic 1: Introduction.
- Topic 2: Operating system structure.
- Topic 3: Process Management.
- Topic 4: Scheduling.
- Topic 5: Memory management.
- Topic 6: Shell scripting programming.

Learning objectives

- Explain the objectives and functions of modern operating systems.
- Determine the functional characteristics and design of the elements that make up an Operating System(OS).
- Analyze the importance of each module that make up an operating system.
- Identify the different services provided by the operating system to users and applications.
- Efficient use of services provided by the OS for the design and development of computer applications.
- Critically analyze the characteristics and functionalities of the policies that make up an operating system.
- Describe reasons for using interrupts, dispatching, and context switching to support concurrency in an operating system.
- Evaluate the trade-offs in terms of memory size (main memory, cache memory, auxiliary memory) and processor speed.

Competences The competencies are extracted from `http://www.grauinteraccioicomputacio.udl.cat/export/sites/InteraccioDigital/ca/pla-formatiu/Competencies-GTIDIC-eng.pdf`.

- **CB03**: That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
- **CT3**: Acquire training in the use of new technologies and information and communication technologies.
- **CG3**: Use adequate hardware and software platforms to develop and execute interactive digital applications.
- **CE3**: Basic knowledge of the use and programming of computers, operating systems and databases,and their use in the development of interactive applications.
- **CE7**: Know, manage and maintain systems, services and interactive applications.
- **CE11**: Knowledge of the characteristics, functionalities and structures of the operating systems and design and implement applications based in their services.

Evaluation Activities	Weight	Minimum Mark	Groups	Mandatory	Recoverable
First Exam (P1)	15%	YES >= 5	NO	YES	YES
Second Exam (P2)	15%	YES >= 5	NO	YES	YES
Challenge *1 (R1)*	10 %	YES >= 5	YES	YES	YES
Challenge *2 (R2)*	15%	YES >= 5	YES	YES	YES
Challenge *3 (R3)*	10 %	YES >= 5	YES	YES	YES
Challenge *4 (R4)*	15 %	YES >= 5	YES	YES	YES
Tracking	20%	NO	NO	NO	NO

Figure 1: Evaluation for Operating Systems course 20/21

Evaluation

- To pass the course, the final grade must be greater than or equal to 5.
- The exams are done with a computer and the students are allowed to consult their notes. Both practical and theoretical content is evaluated.
- In case of plagiarism, the grade for that activity is 0.
- The tracking activity represents the realization and delivery of problems or complementary activities proposed in the classroom, as well as the participation in sessions.
- The presentation of activities with retard represents a weighting of 75% on the weighting of that activity.

Week	Theory (Virtual)	Async Theory (Virtual)	Laboratory (Face-to-face)	Homework
1	**Topic 1**: Presentation / Introduction	***HandsOn-01:*** *Introducció a Linux*	Unix Programming with C	**R1**:Unix Kernel
2	**Topic 2**:Structure of the Operating System	***HandsOn-02:*** *Spying and modifing the Kernel*	Unix Programming with C	
3	**Topic 3**: Process Management	Process Management Problems	**Topic 6:** *Shell Script Programming*	
4	**Topic 3**: Process Management (Pipes)	***HandsOn-03:*** *Gestión de Procesos*	**Topic 6:** *Shell Script Programming*	**R2**: Unix Shell
5	**Topic 3**: Process Management (Signals)	***HandsOn-04:*** *Room Scape*	Process Management Problems	
6	**Topic 3**: Process Management (Threads)	***HandsOn-05:*** *Threads*	**Topic 6:** *Shell Script Programming*	
7	**Topic 4**: Scheduling of the CPU	Scheduling of the CPU Problems	**Topic 6:** *Shell Script Programming*	
8	**Topic 4**: Scheduling of the CPU	Scheduling of the CPU Problems	**Topic 6:** *Shell Script Programming*	**R3:** Daemon
9	**1st Exam**			
10	**Topic 5:** Memory Management	Memory Management Problems	**Topic 6:** *Shell Script Programming*	
11	**Topic 5:** Memory Management	Memory Management Problems	**Topic 6:** *Shell Script Programming*	**R4**: CPU scheduler simulator
12	HOLIDAY	***HandsOn-06:*** Introduction to RUST	**Topic 6:** *Shell Script Programming*	
13	**Topic 5:** Memory Management(Virtual Memory)	***HandsOn-07:*** Memory Management with RUST	**Topic 6:** *Shell Script Programming*	
14	Virtual Memory Problems	HOLIDAY	HOLIDAY	
15	HOLIDAY	HOLIDAY	Validation and Presentations	
16	**2nd Exam**			
17				
18				
19	**Recovery**			

Figure 2: Working plan for Operating Systems course 20/21

1.4.2 System Administration and Virtualization

This subject of System Administration and Virtualization is the natural extension of Operating Systems, Networks and Databases (second-year courses). It is taught in the last year of the degree in Digital Interaction and Computing Techniques of the University of Lleida. It is part of the compulsory module.

This course is designed to introduce students in the vast ecosystem of information, technologies and skills related to UNIX and Linux system administration and virtualization technologies. This course has been taught as an orientation guide where we review the central administrative systems tasks, identify the different pieces and architectures of servers and data-centers and how they (work/interact) together. The course teaches students the advantages and disadvantages of the most popular design and configuration options.

Subject contents

- Topic 1: Introduction.
- Topic 2: Basic server administration.
- Topic 3: Basic server configuration.
- Topic 4: Storage and File-systems.
- Topic 5: Basic Maintenance.
- Topic 6: Basic security.
- Topic 7: Virtualization and administration.
- Topic 8: Cloud computing.

Learning objectives

- Gain a basic knowledge of Systems Administration.
- Design systems according to user requirements.
- Install, configure and maintain servers.
- Protect systems, data and services.
- Identify threats and plan strategies to prevent them and to build emergency and contingency plans
- Use virtualization in systems administration.
- Know the basics of cloud systems.
- Gain a basic knowledge of how to use and manage a cloud platform (AWS).
- Improve critical thinking evaluating different case studies and disruptive technologies.

Competences The competencies are the same as the Operating System course. See 1.4.1.

Methodology Apart from the standard methodology, this course promotes a scientific conference (TIDIC-CLOUDOPS) where students in groups will have to work on a disruptive and very current technology related to Cloud and Virtualization. They must present proceedings explaining the subject and complementing with a state of the art revision. Moreover, the students must go a step further and discuss the pros and cons of the technology accompanied with a real-world situation where they recommend to use it. Afterwards, each group will make a public presentation of the topic and a tutorial showing how this technology can be used. The topics for the course 20/21 where (CEPH, KVM, OpenNebula, Rancher, Kubernetes, Indentify and Access Management in the cloud, and Snort)

Evaluation

- To pass the course, the final grade must be greater than or equal to 5.
- The exams are done with a computer and the students are allowed to consult their notes. Both practical and theoretical content is evaluated.
- In case of plagiarism, the grade for that activity is 0.
- The HandsOn activity represents the realization and delivery of problems or complementary activities proposed in the classroom, as well as the participation in sessions.

Evaluation Activities	Weight	Minimum Mark	Groups	Mandatory	Recoverable
*First Exam (**P1**)*	15%	SI >= 5	NO	SI	SI
*Second Exam (**P2**)*	15%	SI >= 5	NO	SI	SI
*Project (**P**)*	30%	SI >= 5	SI	SI	SI
*TIDIC-CLOUDOPS (**TCO**)*	20 %	SI >= 5	SI	SI	SI
*HandsOn (**HO**)*	20%	NO	SI	SI	SI

Figure 3: Evaluation for System Administration and Virtualization course 20/21

Week	Theory (Virtual)	Lab (Face-to-Face)	Homework (TIDIC-CLOUDOps)	Homework
1	**Topic 1**: Presentation / Introduction	Scripting Review	*Topic selection & resarch*	Project HandsOn
2	**Topic 2:** Basic Administration	**Topic 2:** Basic Administration	Abstract + Introduction	
3	**Topic 3:** File System	**Topic 3:** File System	*State of the art*	
4	**Topic 4:** Basic Configuration	**Topic 4:** Basic Configuration	*Proposal*	
5	**Topic 4:** Basic Configuration	**Topic 4:** Basic Configuration	*HandsOn*	
6	**Topic 5:** Storage	**Topic 5:** Storage	*HandsOn*	
7	**Topic 6:** Basic Security	**Topic 6:** Basic Security	*HandsOn*	
8	**Topic 7:** Basic Maintenance	**Topic 7:** Basic Maintenance	*HandsOn*	
9	**1st Exam**			
10	**Topic 8:** Virtualization	**Topic 8:** Virtualization	*Slides*	
11	**Topic 9:** Cloud Computing	**Topic 9:** Cloud Computing	*Slides*	
12	*HOLIDAYS*	**CloudOps**	-	
13	**CloudOps**	**CloudOps**	-	
14	***Case Study 1***	*HOLIDAYS*	-	
15	***Case Study 2***	**Project Validation**	-	
16	**2nd Exam**			
17				
18				
19	**Recovery**			

Figure 4: Working plan for System Administration and Virtualization course 20/21

1.4.3 Applications for Mobile Devices

This subject of Applications for Mobile Devices is taught in the second year of the GTIDIC of the University of Lleida. It is part of the compulsory module. This course seeks to enhance how to properly code, evaluate, test and launch android apps (using Java [1]) and APIs (Python framework - Falcon [2]).

This project-oriented course examines the principles of mobile application design and development. Students will learn application development on the Android platform. Course work includes project conception, design, implementation, and testing. Topics includes memory management, user interface design,notifications, storage, data handling, implementation and usage of APIs, and device sensors. Students are expected to work on a project that produces a professional-quality mobile application.

Subject contents

- Topic 1: Introduction to Android.
- Topic 2: User UX.
- Topic 3: Storage.
- Topic 4: Internet, Communication and Services.
- Topic 5: Performance and Testing.
- Topic 6: Back-end development.

Learning objectives

- Understand the Android platform and the elements that make it up.
- Understand the most recommended and used development environment.
- Develop applications for the Android operating system.
- Develop and use backends.
- Establish the bases for the implementation of additional functionalities (access to the database, access to resources and features of the mobile, etc.).
- Get to know the step of publishing Android applications.

Competences

- **CB02**: That students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- **CB03**: That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
- **CB04**: That students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
- **CT3**: Acquire training in the use of new technologies and information and communication technologies.
- **CG1**: Conceive, plan and developed projects in the field of ICT
- **CG2**: Design, develop, evaluate and guarantee the accessibility, ergonomics, usability and security of computer systems.
- **CG4**: Use software engineering methods to develop interactive ICT applications.
- **CG7**: Solve problems through initiative, determination, independence and creativity.
- **CE3**: Basic knowledge of the use and programming of computers, operating systems and databases,and their use in the development of interactive applications
- **CE6**: Capacity to design, develop, select and evaluate applications and computer systems, ensuring its reliability, security and quality
- **CE10**: Capacity to analyse, design, build and maintain safe and efficient applications, choosing the most suitable paradigm and programming languages
- **CE14**: Knowledge and application of the necessary tools for the storage, processing and access to information systems, including those based on web.

[1] https://java.com/es/

[2] https://falcon.readthedocs.io/en/stable/

Methodology Apart from the standard methodology, this course promotes an active methodology where the student is the protagonist of their learning (**learning to learn**) and is responsible for deciding what final product they want to develop and what knowledge they need to achieve the objectives of each delivery.

Furthermore, the course propose a cooperative methodology, where students work in teams of 3 to 4 members. They will incrementally develop an innovative app. The different working rhythms of each group are respected. The deliveries are functional, with constant feedback and suggestions from the teaching staff and the rest of the teams, allowing pivoting actions and corrections.

All activities and deliveries are carried out under the umbrella of a **common project** to develop innovative applications. This joint project is developed in 4 courses: **Interactive System Specification and Analysis, User experience, Innovation in ICT and Applications for Mobile Devices**. In the project, there are three courses (1,2 and 4) focused on essential aspects of application development (requirements analysis, user-centered development, agile methodologies, or design patterns) and a course (3) where you learn to launch innovative projects to the market. The project is focused on encouraging students to face a real scenario, which aims to consolidate an innovative startup based on an application for mobile devices and develop skills related to organization, communication, and human relations to coordinate the team and learn to sell the ideas.

Finally, the projects are also evaluated by a jury composed of members of TICAnoia [3] and the best project receives the prize TICAnoia al millor projecte integrador TIDIC. The projects developed during the course 19/20 can be found in startapp website[4].

Evaluation The evaluation of the course contemplates the acquisition of the specific competencies of the course with a weight of 80% (partial+milestones). This 80% represents the realization of the activities and deliveries related to the project and the content validation exams. The remaining 20% (common project) represents the mark of teamwork and the completion of the project.

- To pass the course, the final grade must be greater than or equal to 5.
- The exams (P1, P2) are practical; they are done with the computer. Class notes and internet searches are allowed. The exam must be done individually. It's about solving @TODO, @EXPLAIN, @FIX, in a given GitHub repository. All students perform different tasks.
- The project can be completed without the need to enroll all four courses at the same time. Students who do not enroll in the four courses will have the same evaluation, with the difference that they will be forced to lead the parts of the project and the final presentation of the enrolled courses; this encourages the increasingly common figure of the freelance.
- At the end of the course, all the teams will receive a summary report of their achievements, with the evaluations of the teaching staff, the members of the jury, and their colleagues.

The other 20% is a common mark in the four courses that make up the project. This grade is calculated by teachers and student evaluations, personal contributions to the project, consistency, and organization in the development of the weekly tasks. It is based on two blocks:

- Final presentation (StartApp Contest). Public defense in front of a jury in a format similar to a real investment round. Design,usability, and MVP must also be justified in this presentation. It weighs 10% of the final grade.
- Monitoring and Management. At this point, the teaching staff will follow up intensively in control meetings. The use of the Github and the update of the WordPress of each team will also be evaluated. Finally, management and organization skills will be considered by using project management methods and tools that will be presented in the courses. It weighs 10% of the final grade.

[3] `https://www.ticanoia.cat/`

[4] `https://jordimateoudl.github.io/`

Evaluation Activities	Weight	Minimum Mark	Groups	Mandatory	Recoverable
*First Exam (**P1**)*	15%	SI >= 5	NO	SI	SI
*Second Exam (**P2**)*	15%	SI >= 5	NO	SI	SI
*Project (**P**)*	30%	SI >= 5	SI	SI	SI
*TIDIC-CLOUDOPS (**TCO**)*	20 %	SI >= 5	SI	SI	SI
*HandsOn (**HO**)*	20%	NO	SI	SI	SI

Figure 5: Evaluation forApplications for Mobile Devices course 20/21

Week	Theory (Virtual)	Lab (Face-to-Face)	Homework	Milestones
1	**Topic 1** - *Introduction to Android platform*	*Project Architecture (Docker, Servidors, App)*	**A1:** Preparation and Familiarization	**M1: App skeleton**
2	**Topic 2** - *UX: Layouts, Widgets, Themes*	**Topic 2** - *UX: Layouts, Widgets, Themes*	**A2:** Splash Screen, Branding, Logo	
3	**Topic 3** - *Activities, Lifecycle and Comunication*	**Topic 4** - *Testing*	**A3.** User register	
4	**Topic 5** - *Design Patterns*	**Live Coding: MVVM Game**	**A3.** User register	
5	**Topic 6** - API and services (Retrofit)	**Topic 7** - *Storage*	**A4.** User Login	**M2: Common Part**
6	**Topic 8** - *Falcon,SqlAlchemy*	**Topic 8** - *Falcon,SqlAlchemy*	**A4.** User Login	
7	**Holidays Setmana Santa**	*Project*	**A5.** Users profiles	
8	**Tema 9** - *Recycler View*	**Tema 9** - *Recycler View*	**A5.** Users profiles	
9	**1st Exam**			
10	**EPS Party**	*Project*	**A6.Sprint V**	**M3: Specific Part**
11	**Topic 10** - *Menus, fragments and navigation*	**Topic 10** - *Menus, fragments and navigation*	**A6.Sprint V**	
12	**Topic 11** - *Threads*	**Live Coding Location**	**A7.Sprint VI**	
13	**Topic 12** - *Firebase*	Discussion Session	**A7.Sprint VI**	
14	*Project*	*Project*	**A8.Sprint VII**	
15	*Project*	*Project*	**A8.Sprint VII**	
16	**2nd Exam**			
17				
18				
19	**Recovery Exam**			

Figure 6: Working plan for Applications for Mobile Devices course 20/21

2 Research project

In the last decade, the paradigms and contexts related to cloud computing have drastically changed to become the referent for hosting ICT infrastructure. The combination of IoT devices, services and platforms has led to new challenges, trends and concerns, see [1, 2]. The main advantages of cloud computing are offering rapid elasticity and dynamic scalability of resources. This research project aims to address the challenges in the development of elastic and scalable architectures and services in the cloud to improve workflows and coordinate ecosystems where coexist legacy and emerging technology. Significantly, the ones aimed to transform data into knowledge and the latter into decisions that allow us to improve the quality of our society. Even though the challenges addressed by this research will be general-purpose, the main application field will be Health. The main reason is that it is the principal application line of the group the candidate belong to.

2.1 Background

The research context presented by the candidate takes as its main reference the new paradigms and challenges opened by cloud computing services and systems. The beginnings of this research line date back to the candidate's doctoral thesis (Cloud Systems and HPC as a service of agroindustry, 2019). This thesis explored methods, mathematical models and algorithms to manage cloud systems profitably, as well as the design of services that allow data to be transformed into information and this, into knowledge or decisions.

The candidate's main research background is detailed in the attached CV. The candidate is currently integrated in the GCD group, where he is an active member of the group's research project team and is currently collaborating with them and with other groups and research centers. In this research project a brief introduction to future research lines are presented.

2.2 Research proposal

This research project aims to address the challenges in the development of elastic and scalable architectures and services in the cloud to improve workflows and coordinate ecosystems where coexist legacy and emerging technology. This way, a top-down vision is proposed to seek the concerns in different application levels. Figure 7, illustrates this top-down concept, highlighting the main parts and the involved technologies.

If we start in the bottom, we found `Physical Servers`, and next to them the `Virtualization Layer/s` of the resources. This proposal aims to design and orchestrate this layer by combining `Traditional virtualization` (KVM and virtual machines), `Container virtualization` (docker or Linux containers), `Cluster concepts` (Kubernetes) and `Unikernels` to manage efficiently the services implemented on the top of this layer. Therefore, next to this layer, we found the `Service layer`. This layer is the place where resides algorithms, mathematical models, task automation, scripts, and the procedures aimed to transform data into knowledge. Here, we propose to develop method and techniques in the context of `Mathematical Models` (predictive and prescriptive), using `High-performance computing (HPC)` to deal with huge models or big data processing, `Data analysis` and `Data transformation` based on ETLs. These methods store and use datasets and data in the `Data-tier` with relational and non-relational elastic storage. The `Composite tier` aggregate services, which use the resources provided by other tiers. Then, the `Business tier` includes all the methods, services and algorithms used as the core of web or mobile applications. Finally, for this research it is crucial to ensure the `Quality of services (QoS)`, designing `SLAs` contracts that allow maintaining a certain level of quality based on the `availability, reliability, performance, security and costs` of the resources/services offered. Thus, requires integrate rules and models that can be feed with logs and metrics obtained from physical resources, virtual resources and also service resources.

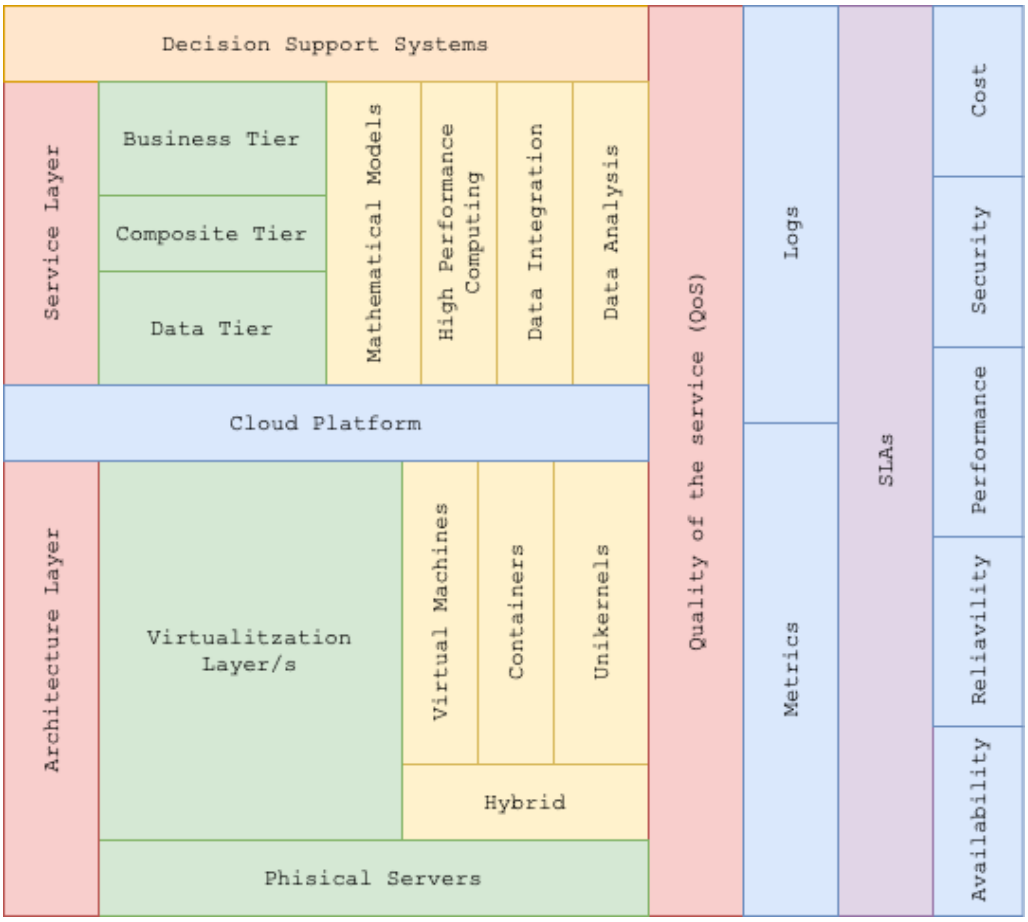

Figure 7: Graphical Abstract of research proposal

2.3 Objectives

1. Guaranteeing QoS and SLAs in real-time environments.
   - Designing and implementing a QoS-aware cloud architecture able to scale up and down according to IaaS and SaaS constraints.
   - Fitting new emerging technology in controlled and elastic architectures aimed at guaranteeing SLAs.
   - Developing load balancing algorithms to avoid overloading/underloading virtual resources or services.
   - Designing hot migration methods of services and resource to adjusts users needs with heterogeneous workloads.
   - Developing models to predict load and peeks of resources saturation.
2. Developing cloud based decision support system.
   - Designing and implementing models (predictive or prescriptive) as a service of society (Anything as a service XaaS).
   - Using neural networks to extract further knowledge from data gathered.
   - Implementing portable and interoperable services and systems capables of scaling and adapting to users'need.
   - Building ecosystems where traditional tools and emerging innovation can coexist and cooperate.

- Using high performance computing to speed up the resolution of models, algorithms and data analysis techniques.

3. Transferring expertise and know-how to society: Optimizing services, web and mobile applications and platforms to assist decision making in Health, Agrobusiness and other economical sectors.

2.4 Methodology and work plan

The research methodology will use both modelling and experimental techniques. The modelling methodology will allow to study expected performance results, and the experimental methodology will apply it to real scenarios and contexts.

2.5 Research Impact

The results of the research will be disseminated through the publication of articles in specialized indexed journals and the presentation of these achievements and data to international conferences. The most practical successful stories will be published in less academic and more informative publications to promote the transfer of knowledge. Besides, to favour the reuse and reproduction of results, all developments will be kept in public repositories (as far as possible). As a summary, the expected impact is detailed in the following points:

- To go further of the current research line based on cloud-based architectures. It is intended to explore the challenges in guaranteeing QoS and SLA as well as the elasticity and scalability of cloud architectures and services.
- To go further of the current research line based on developing cloud-based services (DSS) to assist Health, Agrobusiness and other economic sectors to make better decisions.
- Initiation of a new line focused on serverless architectures and unikernels.
- Collabartion with other research groups and companies with sensors and iot, fog and edge architectures to integrate data into decision support systems.
- To keep assisting SADeH (eHealth Advice and Development Service) to transfer qualified research, expertise and know-how from academia to society.
- Competitive projects: one of the objectives of this research project is to be able to obtain funding from competitive research projects jointly with researchers from the GCD group of the Udl and other organizations and research groups.
- Supervision of Doctoral Theses - PhD Students: it is intended to supervise Doctoral Thesis framed within the lines of research of this project. Currently, two PhD students are being co-directed by the candidate. The first is based on the development of algorithms and services to manage the population cancer registry of Lleida health region. The second is based on adopting blockchain protocols and technologies to accelerate the integration of resources and services in the cloud.

The candidate is a member of a SADeH (eHealth Advice and Development Service). This service aims to be a platform to transfer the research results into the society, being capable of offering solutions to different institutions including hospitals, biomedical research centres and private companies.

The candidate intends to use his current connections and project experience to lead his own projects, focusing on competitive calls such as calls for national and European research projects.

He also plans to carry out more research stays. He is currently requesting a research stay within the HPC-Europa3 project.

References

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