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Πτυχιακή Εργασία

Τίτλος: Design, develop and implement a Human Resources system combined with desktop client for asynchronous data entry.

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Abstract

The aim of the thesis is to design and develop a Human Resources system that will track the hours and the work carried out by its users, allowing the company to better assess and supervise its staff. Furthermore, using our system, a company will be able to organize its projects and easily assess risks. Historic data are kept and could be visualized with charts and reports.

Σύνοψη

Ο στόχος αυτής της εργασίας είναι ο σχεδιασμός και η ανάπτυξη ενός συστήματος Ανθρώπινου δυναμικού που θα αποθηκεύει τις ώρες εργασίες που εισάγουν οι υπάλληλοι μιας εταιρίας. Αυτό επιτρέπει την εταιρία να αξιολογεί και να επιβλέπει τον προσωπικό της. Επιπλέον, χρησιμοποιώντας το σύστημα, μια εταιρία θα είναι σε θέση να οργανώνει τα έργα της και να εκτιμήσει το ρίσκο για αυτά με ευκολία. Το σύστημα κρατάει όλη την πληροφορία που χρειάζεται ώστε να μπορούν να παραχθούν reports και σχεδιαγράμματα.

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1. Introduction

The thesis is one of the most crucial assignments for any student as it will help him/her tackle a broad problem and put the skills and the knowledge he/she accumulated while studying to the test. The students must use analytical thinking and produce apt results in a timely fashion, which are both core aspects of any professional in our sector.

1.1. Summary

We will try to provide a solution in a small area of Human Resources, Time management. Every company needs to keep track of the work log of all its employees and be able to accurately assess risks, have a complete overview of its finances and manage its human workforce as efficiently as possible.

This project is focusing on staff management and project management. For staff management, we are going to design a Check-in/Check-out system that will allow the company to have up-to-date information about the assignments of the staff and the time spent for each one of the assignments. For project management, we are going to create a fine-grained Business Model that contains the hierarchy and relationships of Business Objects. This is a very important aspect to support big and complex companies/organizations. With a detailed Business Model, Project Management Office (PMO) will be able to export very useful reports for each project and use it in a feedback loop to eventually improve staff allocation and the productivity of the company.

To cover the needs of this system we will create a web site, a web api and windows-based application. The web site will be our main portal to manage all our data. Aside from this, we will need a different channel that is able to work while offline. For that we will need a web api and a windows-based application.

For the development of the HR Information System we will follow the Software Development Life Cycle (SDLC) procedure and the appropriate patterns for the implementation.

We will use Microsoft's software development platform. The data processing of the system is based on relational data models. The basic scope for the software is the delivery and to expose the data to the Clients using Asynchronous procedures such as the REST calls. The clients need the data for managing their time entries in the system.

Technologies required by the project:

- Combination of Web Platform and Desktop Platform
- Web interfaces for the data entry
- RESTful Web API
- Windows-based Client application with REST calls
- RDBMS for data storage

We are going to use .Net Framework 4.5 and C# because Microsoft provides all the right tools and technologies to develop our system. We will be working on top of a very robust platform which can cover the whole spectrum of technologies needed for the solution and of course excellent tools to work with Microsoft's SQL Server which seamlessly integrates with the platform.

Specifically:

- ASP.NET MVC 5 for our web site
- ASP.NET WebApi 2 for a RESTful Web API

- ❑ WPF for the windows-based client application
- ❑ SQL Server for data storage

1.2. Motivation

The main motivation for our thesis has been to share knowledge and gain experience in one of the most widespread frameworks. We have worked in the past in companies that didn't have software for this process and we know first-hand the importance of applications like this. Delivering a system that spans the full stack will make it easier for us to find a job. With this thesis, we hope to close the gap between the student we are now and the professional developers we want to be.

1.3. Goals

- Create a modern, easy to use platform that focuses on user productivity.
- Research the latest technologies in web development.
- Learn the full-stack of technologies available in the market right now.
- Familiarize ourselves with the main processes that all the companies have.

1.4. Thesis structure

Chapter 2: In this chapter, we are going to research Human Resources Management Systems (HRMS) and all the related HR operations focusing mainly on Time Tracking. Furthermore, we are going to describe Project management and explain why it so very important for every company. In both areas, we are going to compare our approach to the competition and provide the state-of-the art implementations currently available.

Chapter 3: We are going to emphasize on the tools that we used to design and develop our system, their history, how they relate today and the reasons we chose them.

Chapter 4: This is the chapter with all the implementation details for our solution. It starts with the specifications of the system, followed by its architecture and finally the application workflow for both clients (website and wpf). We are going into an in-depth analysis of some of the most important technical approaches that we used.

Chapter 5: This is a rather small chapter that contains all the conclusions after working on this project.

Chapter 6: In this chapter, we are going to focus on future work. After working on a project like this, we now have the ability to compare and decide on best-practices, favored approaches based on a specific goal and of course explain and define and unfinished work that should be done to provide a more complete solution.

2. State of the art

Nowadays, the Information Technology (IT) is very important for the Business. The Business of each Company/Organization has many operations and an Information System can help the Company/Organization to resolve many problems with automation mechanisms. Human Resources is necessary and one of the most important departments that every company or organization needs. The Human Resource management procedures describe the responsibilities and the processes in relation to recruitment and employment arrangements, the staff development and the workforce management.

2.1. *Human Resources (HR)*

Human Resources (HR) is a very important department for a Company / Organization. HR refers to the workforce responsible for performing the tasks given to them to achieve the goals and objectives of the Company / Organization. HR is responsible for main factors for the operations of the Company / Organization related to the hiring process (recruitment and selection), providing proper orientation during the induction of new employees, the training procedures and the skill development, the proper assessment of employees, providing compensation and benefits, maintaining the proper labor and internal regulations and also the workforce safety and health.

2.2. *Human Resources Management (HRM)*

Human Resources Management is very important procedure for every Company/Organization. Generally, the Human Resource Management (HRM) is the process of employing people, training the employing people and compensating them. Also, related to the employing people the most important procedure are to develop crucial policies related to them and develop the appropriate strategies to retain them.

If we compare the present state of HRM to its past, we will find many differences related to the operations and the policies. In the past, the role of HRM was a more administrative role rather than a strategic role crucial to the success of the Company / Organization. For example, basic operations were processing the payroll, sending the birthday gifts to the employees, arranging the company outings and of course the classical making of registration forms.

It's very important to note that the HR Managers has important role relating to human resource management. Most managers have the policy related the HRM for compensation, motivation, and retention of the employees.

2.3. *The Role of HRM*

In this section, we will see the seven main roles (**Figure 1**) that HRM plays in organizations. These are described in the following sections.



Figure 1: Seven roles of HRM [1]

2.3.1. Staffing

Staffing is very important for the Company / Organization. For the internal structure, the business operations the Company / Organization need people to perform tasks. The procedure of Staffing involves the entire hiring process. The hiring process is very important with many features and operations. More especially, the posting of a job, the research of candidates and to negotiate a salary package [1].

About the progress of the staffing function we have four main steps such as [1]:

1. The Development of the staffing plan, which is the management of the business parts to see how many people they should hire for catering the tasks and jobs of the business operations.
2. The Development of the policies for the staff, which is the multiculturalism in the workplace. It's very important and complicated because we have many and different people from a variety of backgrounds.
3. The Recruitment process, which involves the hiring process for finding the appropriate candidates to fill the open positions.
4. After the hiring process, the next stage is to be followed by training, retention, and motivation of the new employee to integrate in the Company/Organization environment.

2.3.2. Retention

Another main role of HRM is the Retention which involves keeping and motivating the employees to stay aligned with the Company / Organization. Furthermore, a major factor in employee retention is the compensation. The crucial factors for the employees to leave the Company / Organization are: losing interest in their job, the challenges with their manager and of course the poor fit with organizational culture and poor workplace environment which is very important for the employees [1].

2.3.3. Training and Development

After the hiring process, the next important process is the training of the new employee to integrate in the Company/Organization environment. Firstly, we have the training related to the business areas and operations of the Company/Organization and subsequently comes the technical training based on the job profile. Training schedules for the employees may be: the Job skills training, the training on communication, team activities, legal training, ethics training and policies [1].

2.3.4. Regulation and Laws

Every Company/Organization and in general the workplace must have regulations and the employees must be aware of all the laws that affect the specific workplace. Important regulations and laws are: The discrimination laws, health-care requirements and the compensation requirements such as the minimum wage, the Worker safety laws and of course for all employees the labor laws [1].

The regulations and laws are very important for the Company/Organization. The environments are always changing, so the HRM must always be aware of changes. The HRM must communicate with the staff for those changes [1].

2.3.5. Worker Protection

Safety and the protection of the employees is a major consideration for the Company/Organization. Regulations and laws are related to state standards to ensure worker safety. Worker protection might include: Chemical hazards, the heating and ventilation requirements and generally the protection of private employee information [1].

2.3.6. Development of Workplace Policies

About the Company/Organization the role of policies is very important. The Company/Organization has policies to ensure fairness and continuity within the organization. The HRM must develop the verbiage surrounding the appropriate policies. In this process the HR department does not and cannot work alone. The HR department needs to involve all other departments in the Company/Organization. Keys are the HRM, management and the executives form the business areas. This team process is responsible for the recognition of the needs for the policies, modifications or deletions of policies and the final registration of the policies [1].

2.3.7. Compensation and Benefits Administration

Compensation is very important for the staff. HRM need to determine that compensation is fair for the employees and of course meets the industry standards. The compensation includes all the resources the employee receives from work. About the employee compensation might be the following: the payments, the health benefits, the vacation time, sick leave, bonuses and more [1].

2.4. Check-In / Check-Out System

To the Company/Organization the Check-In/Check-Out System is very important for the staff management. Check-In/Check-Out System is a specific type of asset tracking that is focused on circulatory assets. In this asset tracking system, each entity such as the employee will be uniquely identified with a specific code (staff code). With this uniqueness, we can start tracking Check-In/Check-Out System transactions.

Beyond the everyday tracking procedures, the Check-In/Check-Out System provides detailed reporting on asset usage. The asset usage is very important for the management of the human resources for the Company/Organization. The HR have a record of every transaction about the entities related the Check-In/Check-Out movements.

Generally, the movements of the employees in the business operations for the Company/Organization are very important. Keeping track of how the employees are allocated in the various projects and how they spend their time on each project is a crucial factor for the business using reports and Data Analysis/Data Mining of these information's to optimize productivity.

The Company/Organization uses an Information System (IS) for assets tracking that checks the workers in and out of the office by tracking their location. Nowadays, the software is available in CROSS architecture in many platforms (Web, Desktop and Mobile) with operating systems platforms (iOS, iPad, Android, Windows) and technologies such as GPS and smartphones tracking the movements with accuracy.

At the end, Check-In/Check-Out Systems are very important for the Company/Organization to track the assets and especially the Human Resources movements and using procedures such as GPS-tracking, alerts for administrators and automatic notifications, the system is very reliable and helps to optimize the productivity.

2.5. Competition and alternatives on HRM software

Considering the importance of HRM in every company's procedures, it is no surprise that there are many software suites that cover the full breadth of HR operations. We are going to selectively list some of them.

2.5.1. SAP ERP

SAP ERP is enterprise resource planning software developed by the German company SAP SE. SAP ERP incorporates the key business functions of an organization. The latest version (SAP ERP 6.0) was made available in 2006. The most recent Enhancement Package (EHP8) for SAP ERP 6.0 was released in 2016. Business Processes included in SAP ERP include Operations (Sales & Distribution, Materials Management, Production Planning, Logistics Execution, and Quality Management), Financials (Financial Accounting, Management Accounting, Financial Supply Chain Management) and Human Capital Management (Payroll, e-Recruiting) [2].

It is one of the biggest platforms in the market and it is used extensively in the enterprise world from all different sizes of companies and organizations. In this case, we are interested in one of the many components that SAP ERP has, Personnel Time Management.

The Personnel Time Management component offers you support in performing all human resources processes involving the planning, recording, and valuation of internal and external employees' work

performed and absence times. It provides other SAP applications with planning data and delivers information to business processes such as:

- Determining personnel costs
- Creating invoices
- Confirmations
- Service entry of external employees

Time Management has user-oriented interfaces that support centralized and decentralized entry and administration of time and labor data. Data can be processed centrally by administrators in the human resources department or else in individual departments by time administrators such as supervisors, secretaries, and employees themselves.

Time Management enables you to record time and labor data online or using self-service applications. The self-service applications range from the classic time recording subsystem, through Web applications, to mobile business applications. Employees can use these applications to request leave, record working times for orders or projects, for example, and display their key time accounts.

Time Management allows you to represent all company agreements, collective agreement stipulations, and legal requirements the world over. It is highly flexible, meaning that you can support new concepts such as managing long-term time accounts [3].

Compared to our approach, SAP is a more complete solution with many components and tries to address all the needs even the biggest enterprises may have. The biggest selling point of this software is its customization seamless integration between its modules.

On the other hand, SAP is very complex to setup in your company and although there are many SAP certified partners all over the world, the migration project from anything else to SAP can be very expensive and with high risk.

Our approach cannot compare to SAP in terms of completeness although we have implemented the offline time entries feature that is not supported by SAP. We are mainly focusing in simplicity, ease of use, and to provide simple inexpensive solutions that can be adopted by the smallest companies.

2.5.2. *MoneyPenny*

MoneyPenny is another full-featured HRM suite, but with a more modern interface than SAP. It is ranking very high with many positive reviews [4].

Some of its main features are [5]:

- Time tracking: Track, log and invoice time on projects or even on specific tasks.
- Tasks Management: Create projects and tasks. Manage them individually without messing things up

This suite, although it cannot be compared to ours feature-wise, is comparable in the mentality as it is very sleek and wants to provide simple user interfaces. It even supports features like offline time tracking.

2.6. *Project Management*

We have many different definitions of what constitutes a project. Generally, the Project Management is the planning, organizing, directing and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Also, the Project Management utilizes the systems approach to management by having the functional personnel assigned to a specific project (Figure 2).

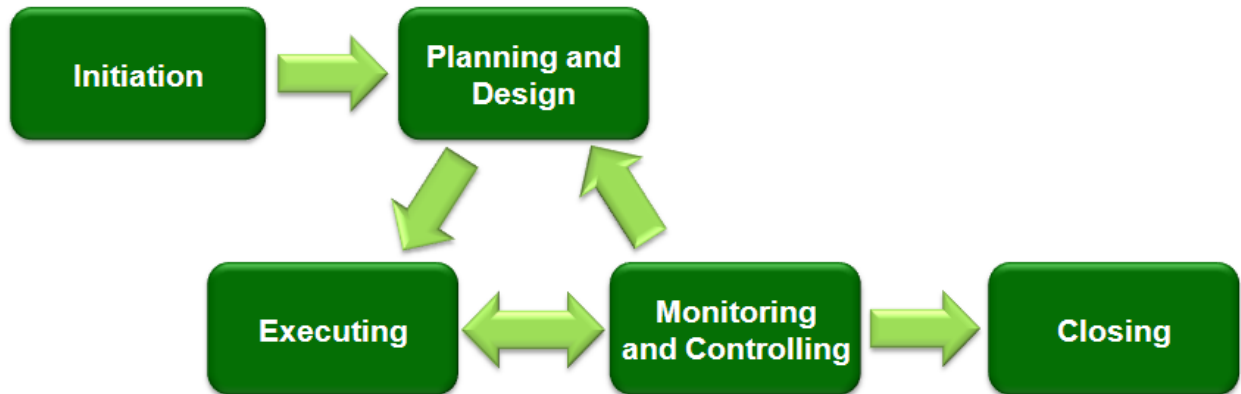


Figure 2: Project Management [2]

Projects have the following characteristics: a definite start and endpoint, the endpoint is reached when the project is over and they are attempting to achieve something new.

Generally, the Projects characterized from many important features and operations. The Projects can vary in size and can be planned and managed by the same or different persons. The role of Manager is very important for the Projects. Managers must have strong management skillset but, since some larger projects may employ hundreds of people working on many sites, the project manager needs the right tools to effectively coordinate everyone and ensure a timely delivery. In many cases, we need multiple managers to work on the same project and this makes the tools even more important.

The key for the Project Management is the following admission. Everything in Company/Organization can be categorized as a project or process. All the procedures from the business sectors and other are projects. The projects are implemented from the staff. For the Project Management is very important the Human Resources allocation to the projects, working log and more. All the previous parameters are very crucial for the final costing of the project.

About the Project Management we have many and important Information Systems (IS). These Systems have all the appropriate operations for the business areas to implement all the staff actions. For example, in our business scenario Check-In / Check-Out and Project Management for the staff.

The basic scope of the Project Management is to eliminate the high level of risk. The risk is the basic term related the projects. Every Company/Organization wants the projects to success. The success of the projects is depending from many parameters such as the planning, human resources, general resources, the managers and more. The risk of failure is important for the Company/Organization. So, the scope is to eliminate the risk.

2.7. Competition and alternatives on Project Management software

2.7.1. JIRA

Arguably the most well-known and hyped software in the enterprise world today is JIRA. It is a suite with many modules that each one of them excels in what it does.

According to Atlassian, Jira is used for issue tracking and project management by over 25,000 customers in 122 countries around the globe. Some of the organizations that have used Jira at some point in time for bug-tracking and project management include Fedora Commons, Hibernate, JBoss, Skype Technologies, Spring Framework, and The Apache Software Foundation, which uses both Jira and Bugzilla. Jira includes tools allowing migration from competitor Bugzilla [2].

Jira is offered in three packages [2]:

- Jira Core includes the base software.
- Jira Software is intended for use by software development teams and includes Jira Core and Jira Agile.
- Jira Service Desk is intended for use by IT or business service desks.

Our approach in project management is the simplest that we could think of and is not comparable with any software in the market right now, especially with a platform like JIRA. We would describe our approach as a poor man's project management. As it is only keeping track of the date and is only integrated with our other module (time management).

2.8. Microsoft Development Platform

Microsoft Development Platform is very powerful with many dynamic features and operations for software development and the Information Systems implementation. Microsoft Development Platform consist many Technologies for many architectures and patterns in the software development. In this section, we will refer in some basic technologies related the Information System (TMS) we will develop. These technologies briefly are: .NET Framework, C#.NET, ASP.NET MVC 5, ASP.NET Web API 2, WPF, Microsoft SQL Server.

2.9. .NET Framework

The basic architecture for development is the .NET Framework (**Figure 3**). Is a core environment that supports the development and execution of many types of applications in CROSS architectures and platforms (Web, Mobile and Desktop) .NET Framework enables programing languages for development (C#.NET and VB.NET). Software development for security, portability, and general a common programming model for the Windows platform.

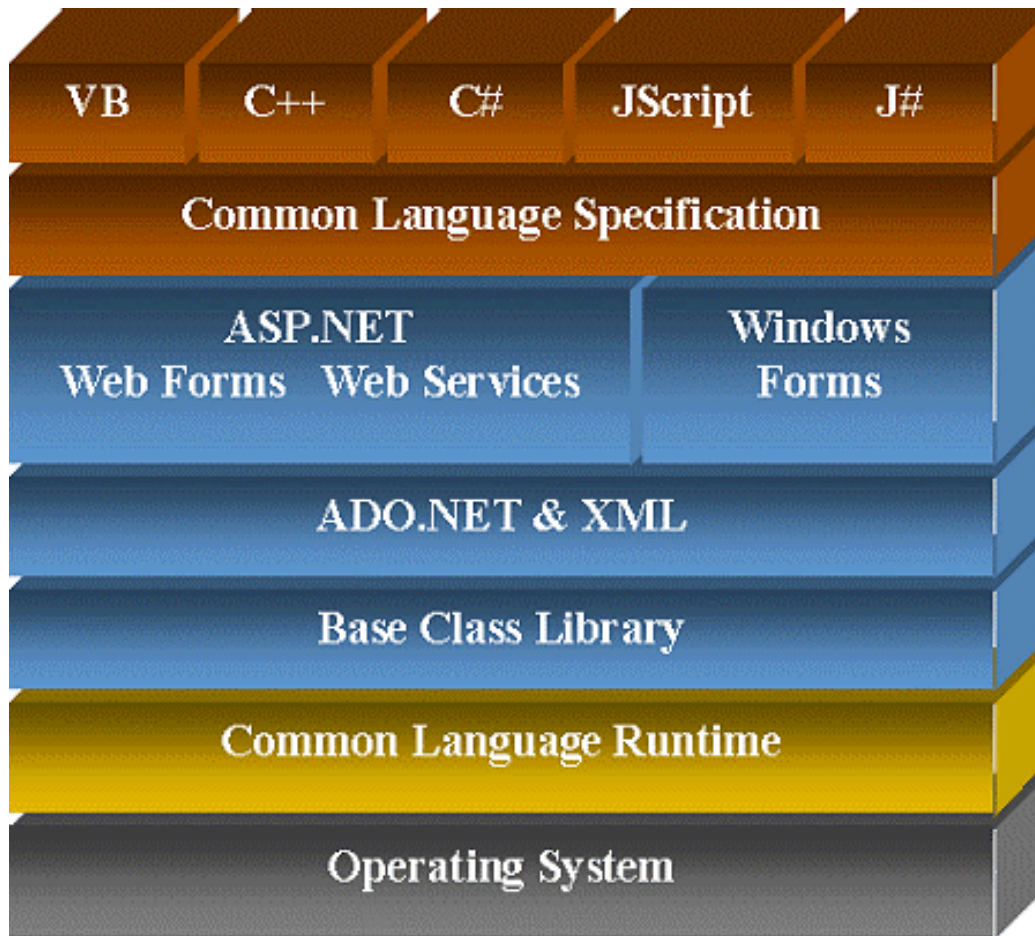


Figure 3: .NET Framework architecture [6]

.NET Framework has two basic building blocks. Firstly, the Common Language Runtime (CLR). CLR is very important because manages the execution of the applications. CLR must be installed in the machines and enable characteristics such as security and portability. Secondly, the .NET Framework Class Library (FCL). Using the FCL the application can access to the runtime environment. For all operations for software, the program must use the .NET library to do it.

It is very important to analyze how the Common Language Runtime works as the CLR manages the execution of our .NET code.

More analytically in this procedure we have the following: When we compile a C#.NET program, the output of the compiler is not executable code. In these environments, we have interpreters instead of compilers. The executable code contains a special type of pseudo code called Microsoft Intermediate Language (MSIL). MSIL is related for the portability for hardware resources (set of portable instructions that are independent of any specific CPU, x86 and x64 architecture). MSIL is a portable assembly language for deployment environments. CLR translates the intermediate code into executable code only at the moment it is required by the running application and not sooner than that. Thus, any program compiled to MSIL can be run in any deployment environment in which the CLR is installed through the .NET Framework. MSIL consist the Metadata, in which describes the data used by the program.

Also, about the .NET architecture we have a crucial factor which is the Just In Time compiler (JIT) compiler. Using a classical workflow about the execution of the .NET program, when the .NET program is executed, the CLR activates the JIT compiler. The JIT compiler converts MSIL into native code on a demand basis as each part of your program is needed. For example, the C# program executes as native code even though it is initially compiled into MSIL.

2.10. C# (Programming language)

C# is a basic and powerful programming language in the .NET framework (**Figure 4**). Generally, C# leverages the time-tested features with cutting-edge innovations. Also, provides a highly usable and efficient way to write programs for the modern enterprise CROSS architectures and platforms (Web, Mobile and Desktop platform).

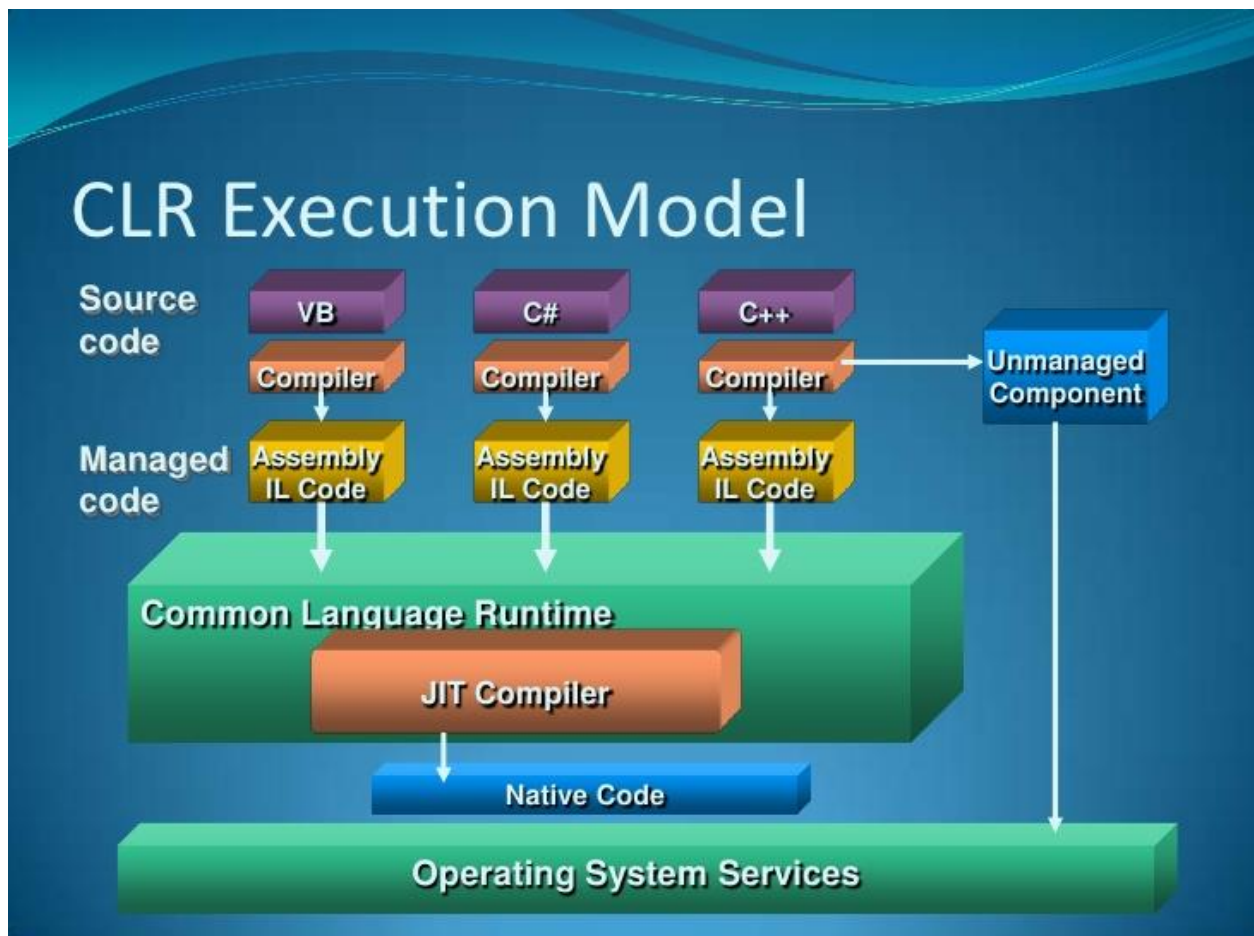


Figure 4: CLR Execution Model [7]

The C#.NET is a programming language relates to the .NET Framework. Using the classes and libraries of .NET Framework can create highly refined programming environment for building powerful applications and software for the Information Systems.

Most popular programming languages from vendors (Microsoft and Oracle) are based in the C and C++ programming languages. Generally, in the programming development we have two basic models: Procedural

and Object Oriented Programming (OOP). C is related to the procedural and C++ is the extension of C for the OOP model. Nowadays, the two most popular programming languages from these vendors, C#.NET and Java, are related to the OOP model.

Starting the history with C, its creation marks the beginning of the modern age of programming. Historically, C was invented by Dennis Ritchie in the 1970s on a DEC PDP-11 that used the UNIX operating system.

The next decade beginning from the 1970s we have the creation of OOP model and C++ programming language. C++ was an extension of C using the OOP features. By the late 1970s, in software development we have much bigger projects in size, which made clear that C and the procedural model could not handle this increase in size. The absolute solution in this problem is a creation of a new model and method for the software development. This model is called Object-Oriented Programming (OOP).

C did not support Object-Oriented Programming features and architecture in the software development style and patterns. The necessity for an Object-Oriented extension of C ultimately led to the creation of C++.

Historically, C++ was invented by Bjarne Stroustrup beginning in 1979 at Bell Laboratories in Murray Hill, New Jersey. The first name was "C with Classes." However, in 1983 final name was changed to C++.

In a few words, C++ contains the entire C language as C#.NET (Microsoft) and Java (Oracle) also do. C++ was designed to support the Object-Oriented Programming model with the powerful features and procedures (Inheritance, Polymorphism etc.). Philosophically, C++ is the Object-Oriented version of C.

In the next decades, the 1980s and 1990s, C++ has seen big overhaul and is the standard for many vendors (Microsoft, Embarcadero, Organizations to support Open Source). Today, C++ is still very important programming language for the development of high-performance software development.

In the next years, the next major advance in programming languages was Java. Java was originally called Oak, it began in 1991 at Sun Microsystems (which has been bought by Oracle). Java is a classical structured and Object-Oriented programming language based in C++.

In the decade of 1990s with the rise of the Public Network (Internet) we have a variety hardware resources (e.g. CPUs) that are closely related to operating system. From this hardware and software architecture the main problem is the portability. In 1990s the solution in this problem of portability was a new language, Java.

The basic architecture of Java is to achieve the portability by translating a program's source code into an intermediate language. This procedure is called bytecode. This bytecode was then executed by the Java Virtual Machine (JVM). Java has the same logic with C#.NET, a Java program could run in any environment and supported platform for which a JVM was installed and active.

Java was and still is very popular programming language. Open issues for programming languages in 1990s were the cross-language interoperability, the ability for the code produced by one language to work easily with the code produced by another. This is a very dynamic feature for the creation of large, distributed information systems.

Microsoft platform in operating systems in the client side is the rule. Windows is the most widely used operating system in the world. Java and other programming languages lacking is full integration with the Windows platform in the section of the operating systems. Of course, the Java programs can be executed in a Windows operating system platform using the Java Virtual Machine but Java and Windows are not closely coupled.

Until the end of 1990s Microsoft did not have a similar Java environment for software development. Visual Studio was procedural without OOP characteristics. Microsoft's answer came in 2003 with the first official release of the new Microsoft development platform, .NET.

With the introduction of .Net Microsoft introduced C#.NET. This programming language such as the VB.NET is based in the .NET Framework with Common Language Runtime (the virtual machine) with architecture and operations familiar to the Java development environment. C#'s chief architect was Anders Hejlsberg, one of the world's leading language experts.

The programming language C# is directly related to C and C++. From the previous reference, we described the history of the C and C++ programming languages were the building blocks for the two 4GL most popular programming languages (by vendors) Java (Oracle) and C# (Microsoft). We currently have the following family tree for two of the most common high-level languages.

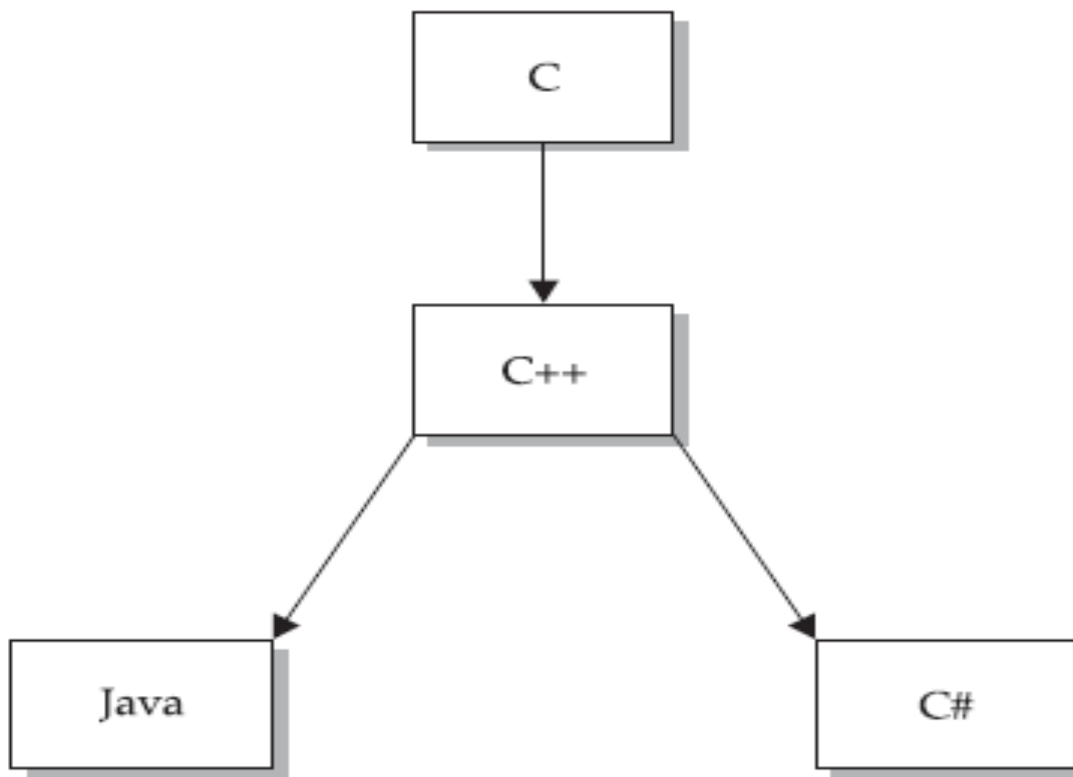


Figure 5: Programming Language Family Tree

C# inherited its syntax and operators from C and the object model, operations with customizations, new researching, add-ons and more from C++. The Microsoft upgrades the language with new versions. A similar feature with Java and the basic scope is to produce portable code using layers for CROSS architectures (Mobile Platform).

The programming language C# is a classical OOP language with OOP features. The basic difference in these programming languages is the frameworks (.NET Framework). C# and VB are the two basic programming languages to support the CLR for software development. Also, C# has been characterized as a component-oriented language because contains procedures to support the writing of software components. C# includes many features that directly support the constituents of components (properties, methods, and events). C#

supports the OOP features and more (Generics, Iterators, Partial classes, Anonymous methods, Fixed-size buffers, Friend assemblies, #pragma directives etc.).

Generally, C# is a classical computer programming language with many operations. Its powerful characteristic is the relationship to its runtime environment, the .NET Framework. Essentially, the basic scope is to manage and handle the .NET Framework. Also, C# was initially designed by Microsoft to create code for the .NET Framework. The classes in this framework were written in C#. At the end we must separate the programming language C# with the .NET environment but the two are closely linked.

2.11. HTML

HTML, which stands for Hypertext Markup Language, is the standard markup language to create web pages that can be displayed to web browsers [8].

HTML has the form of elements represented by tags in brackets <and> e.g. <html>, inside the structure of web pages. Tags are usually surrounded by angle brackets. We usually have the starting tag, the closing tag and the information is added in between. However, there are some tags, known as self-closing tags, that omit their closing part and they display the information in the tag itself [9].

A web browser can read HTML documents and convert the content to visual or auditory web pages. Web browsers don't display the tags but use them to convert their information and determine how to present the elements of the web page [8].

HTML elements are the structure of all the websites. By using them we have the ability to display images, play sounds and furthermore to create interactive forms, lists, headers and many more. At the same time, we can write scripts in other languages like JavaScript that can affect the web page behavior. To display a web page content, like the provision of a text or the form (shape) of a button we use the Cascading Style Sheets (CSS) which web browsers use to display in a specific form the elements of the web page [2].

2.12. CSS

Cascading Style Sheets (CSS) is a style sheet type language which is used to describe the presentation and formatting of an HTML document [2]. Apart from formatting web pages it can also be used to any XML document.

CSS primary task is to separate documents content from documents presentation with of elements like colors, layout, and fonts and so on [2]. In that way, we can obtain the improvement of content accessibility, afford more flexibility and better control in the specification of presentation characteristics of web pages. Yet a further major benefit is the reduction of content repetition as it is written only once something that applies to all the elements of the same type.

A fundamental feature is also the capacity to display many different styles according to the browser in use. Meanwhile you can completely alter the display of a web page by simply changing its CSS. CSS can tailor the elements of a web page according to the size of the screen or of the device illustrating the web page. Another feature is that the reader can use different CSS than the one that was used from the editor of the document and display the web page differently at his device [2].

CSS have a prioritization system of elements. Namely through a number of rules when an element can have different forms CSS determine which form will be implemented. This is a system known as the waterfall model where priorities and weights are converted into rules.

These specifications are maintained from the World Wide Web Consortium (W3C). The media type (MIME) text/css is registered for CSS use by the RFC 2318 (March 1998), and there is a free CSS validation service [2].

2.13. ASP.NET

ASP.NET is an open-source unified development platform, which provides a programming model, a comprehensive software infrastructure and various services. It was developed by Microsoft to allow programmers build up web pages, web applications and web services for computers and mobile devices with a minimum of coding. ASP.NET is part of the .NET Framework, and when coding ASP.NET applications you have access to classes in the .NET Framework [6]. ASP.NET works on top of the HTTP protocol, and uses the HTTP commands and policies to set a browser-to-server bilateral communication and cooperation [10]. You can develop your applications in any language compatible with the common language runtime (CLR), including languages like C#, Jscript, J# and Visual Basic.Net. These languages enable you to develop ASP.NET applications that benefit from the common language runtime, type safety, inheritance, and so on [6]. Initially was released in January 2002 with version 1.0 of the .NET Framework, and is the successor to Microsoft's Active Server Pages (ASP) technology [2].

2.13.1. Advantages of ASP.NET

The flexibility of ASP.NET and the object-oriented features are the main advantages. ASP.NET named after the old Microsoft's technology ASP. However, the new .NET Framework provides CLR for seamless interface connection with other programming languages, like Visual Basic.NET and C#. That means that the programming language of a project may change in the middle of the project, without the need to rewrite everything. It also means that many developers can work on the same project in different languages, like VisualBasic.NET or C#. Another advantage is that the ASP.NET library is task-based. Because the library is organized into hierarchical classes related to a task, like XML or image processing, developers can save time on many common development tasks. Visual Studio.NET also saves developers time, provided that it is installed on a computer fast enough to allow the program to operate with its optimum performance. This IDE is for mass implementation and is equipped with built-in functions for debugging. It also has built-in, IntelliSense, an autocomplete feature that eliminates the need for developers to memorize methods and variables.

2.13.2. Disadvantages of ASP.NET

The main disadvantages of Asp.NET and Visual Studio are the cost and their maintenance that are demanding in terms of resources. Most of the ASP.NET applications run in IIS. Furthermore, ASP.NET uses much more resources than a web server for PHP or other languages, therefore it requires a better server in terms performance and memory, or a cluster of servers to balance out the load. Finally, Windows and IIS have a history background of bugs and flaws of the programs that were prone to their exploitation in the past.

2.14. ASP.NET MVC

The Model-View-Controller (MVC) architecture model separates an application into three main parts: the model, the view and the controller [6]. The ASP.NET MVC framework provides an alternative for the ASP.NET Web Forms template and creating Web applications. The ASP.NET framework is a light, highly testable framework of presentation (as occurs in Web-based applications forms) and it is integrated with the existing features of Asp.NET, like the master pages and the membership-based authentication [6]. The MVC

framework is defined in the System.Web.Mvc assembly. The MVC is a standard design template with which many programmers are familiar to. Some web applications would benefit from MVC framework [6]. Some will continue to use the classical ASP.NET application pattern which is based in Web forms and postbacks. Other types of Web applications will combine the two approaches, no approach does not exclude the other.

The MVC framework includes the following components [6]:

- **Models.** Model objects are parts of the application applying the logic of the applications data domain. Usually the objects model retrieves and stores the state of the model in a database. For example Product object can retrieve information back to a table Products at an SQL server database.
- **Views.** Views are elements displayed at the User Interface (UI) of the application. Usually, this UI is created by the data of the model. An example would be an edit view of a table Products which displays some text boxes, drop-down lists and check boxes based on the current state of an object Product.
- **Controllers.** The controllers are the components that handle user interaction, working with the model, and ultimately select a view which is displayed at the UI. In an MVC application, View displays only information, the controller handles and responds to the user input and interacts. For instance, the controller handles the query-string and transfer these values to the model, which in turn could use these values to search the database.

The MVC pattern helps to create applications that separate the different aspects of the application (input logic, business logic and UI logic), while providing a loose connection between these elements. Specifies the implementation of any kind of logic. The UI logic is part of the Views. The input logic is part of the controller. The business logic is part of the model. This separation helps you to manage the complexity when developing an application, because it enables us to focus on one aspect of the application for a specific time period. For instance, we can focus at the View, without affecting the model. The loose connection between the three main components of MVC application also promotes simultaneous development. For Instance, a developer can work with the Views, a second one can work in logic controller and a third one can focus at business logic of the model [6].

2.15. *jQuery*

jQuery is an open source cross-platform JavaScript library designed to make it much easier to use JavaScript on your website. jQuery at the moment is the most popular JavaScript library in use today, with installation close to 65% of the top 10 million highest-trafficked sites on the Web. Some of the biggest companies on the Web that use jQuery, are Google, Microsoft, IBM and Netflix. Its main purpose is to simplify the client-side scripting of HTML [2]. What does jQuery do is to take lot of common tasks that require many lines of JavaScript code to accomplish, and wraps them into methods that you are able call with a single line of code [11]. jQuery because of the very compact and well written JavaScript code accomplished better performance and increased the productivity of the developer by enabling them to achieve critical UI functionality by writing very small amount of code. Furthermore, provides the ability to developers to create plug-ins on top of the JavaScript library which made possible to create abstractions for low-level interaction and animation, advanced effects and high-level, themeable widgets. Powerful dynamic web pages and Web applications can be created because of the modular approach to the jQuery library. Some of the jQuery libraries are [11]:

- HTML/DOM manipulation
- CSS manipulation
- HTML event methods
- Effects and animations
- AJAX
- Utilities

In addition, jQuery has multiple plugins for almost any task out there.

jQuery, at its core, is a Document Object Model (DOM) manipulation library. DOM is a W3C (World Wide Web Consortium) standard that defines a standard for accessing documents. What jQuery does is to simplify the syntax for finding, selecting, and manipulating these DOM elements [2]. For example, it can be used for finding an element in the document with a certain property (e.g. all elements with an h1 tag), changing one or more of its attributes (e.g. color, visibility), or making it respond to an event (e.g. a mouse click).

jQuery has four principles of developing:

Separation of JavaScript and HTML: provides a simpler syntax for adding event handlers to the DOM using JavaScript, rather than adding HTML event attributes to call JavaScript functions. Thus, it encourages developers to completely separate JavaScript code from HTML markup.

- Brevity and clarity: features like chainable functions and shorthand function names promote brevity and clarity.
- Elimination of cross-browser incompatibilities: jQuery handles all these cross-browser inconsistencies and provides a consistent interface that works across different browsers.
- Extensibility: New events, elements, and methods can be easily added and then reused as a plugin.

jQuery was released in January 2006 at BarCamp NYC by John Resig. Microsoft includes it with Visual Studio for use within Microsoft's ASP.NET AJAX and ASP.NET MVC frameworks. Meanwhile Nokia has integrated it into the Web Run-Time widget development platform. Additionally, it has also been used in Media Wiki.

jQuery 1.x and 2.x versions Firefox, Chrome, Safari, and Opera browsers. Internet Explorer 6 or higher are supported by version 1.x, but in version 2.x Internet Explorer 6-8 were dropped and supports only IE 9 and later versions [2].

2.16. Cookie-based vs Token-based authentication

When you are building a webapi there are some requirements that come above everything else.

- It should be scalable
- It should be easy to consume
- It should be fast and efficient

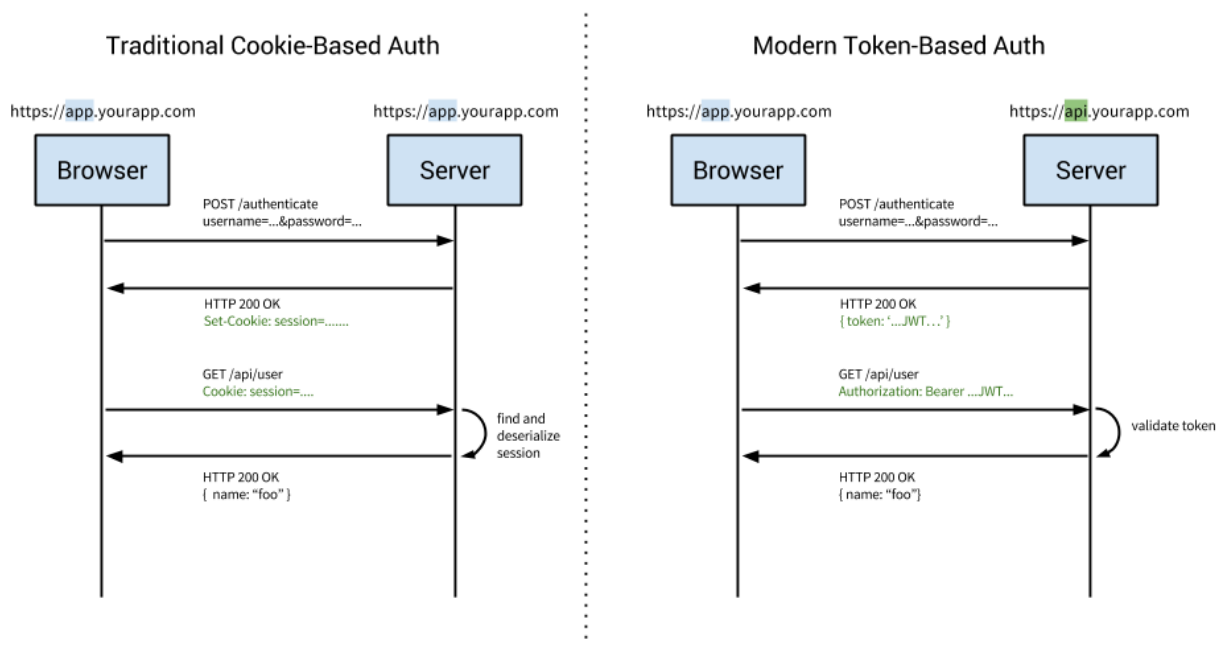


Figure 6: cookie-based and token-based communication examples [12]

2.16.1. Cookie-based

The most important characteristic is that cookie-based authentication is stateful. Both server and client need to keep the cookie information and oftentimes a server under heavy load goes as far as storing the active sessions in a database. This complicates the server infrastructure a lot. Server clusters and farms require server session synchronization, a not so trivial task.

A very simple example that demonstrates the problem:

You have a load balancer and you have two servers hidden behind it.

1. The url of the load balancer is used by your consumers and some send a login request.
2. This request is handled, let's say by server1 and the callers gets a successful login response.
3. The caller then makes another call using his newly created authentication information from the cookie
4. But now load balancer passes the request to server2.
5. server2 cannot validate this request because he is not aware that this session information exists in server1. Returns an unauthorized (401) response.

Another very important detail is that when you want to logoff you have to tell the server because if you don't he will keep stale cookies for some time, which is usually not much due to timer restrictions but still far from ideal.

2.16.2. Token-based

On the other hand, we have token-based authentication which is stateless. Considering the growth of SPAs, mobile devices and the Internet of Things (IoT), being stateless is a very important perk for any technology.

You can have a huge farm of web servers and the only thing they will need to know is how to decode the bearer token. The flexibility provided by this fact is great.

You can arrange your servers however you want, based on your needs:

- Having a farm of servers that process requests independently from each other is now very easy. e.g. It allows you to dynamically bring more servers online in cases of heavy traffic and then shut them down again.
- You may need to have separate login servers (and their database) in case you have many applications under the same account. E.g. you login to a site (handled by the login server) and get a token in application 1 you can then use this token in more than one application and you no longer need to communicate with your login server, in some cases not even for logout.

Other Advantages:

- It is trivial to support Cross Domain and CORS
- You can save the token anywhere you like. This is especially important for native mobile applications (e.g. iOS and Android) that run under a certain restricted context where cookies are not easily managed.

2.17. WPF

WPF stands for Windows Presentation Foundation and it is one of the two subsystems for rendering graphics in windows-based applications, the other being Windows Forms. The main goal of WPF is to create applications with complex graphics and rich user interfaces. It uses DirectX and vector graphics that allow all its visual elements to avoid pixelization. It also provides a clear separation between user interface and business logic. Its view engine is based on XAML which is an XML-oriented object model.

WPF was introduced with .NET Framework 3.0 and its running has been included in all Windows versions after Vista. It was previously known as "Avalon".

Some key features that make WPF a good choice for any windows-based application:

- **Data Binding:** The concept of data binding has taken the internet world by storm and it is one of the selling points for libraries like AngularJS. WPF supported data binding from its first version and it has always been a very much needed (albeit tricky) feature for any WPF application.
- It comes with a complete toolbox of UI elements which are easily reused and extended. Furthermore, it is very easy to create your own custom UI elements.
- **Animations and Effects:** WPF is run by the GPU and is capable of delivering impressive visuals without writing any low-level code or compromising performance.

3. Tools

3.1. *Microsoft SQL*

Microsoft's SQL Server is a relational database management system (RDBMS). It is a full-featured database and like all major RDBMS, SQL Server supports ANSI SQL, the standard SQL language. The primary function of Microsoft SQL Server to store and retrieve data as requested by other software applications- which may run either on the same computer or on another computer across a network (including the Internet) [2]. SQL Server can be used to create and maintain, databases, but also for analyzing data generating reports. SQL Server runs on top of Windows and it is a number of modules where each module is called when needed. It was initially released by Microsoft in 1989 as version 1.0, a 16-bit server for the OS/2 operating system. Since then Microsoft has released the 2000, 2005, 2008 and 2016 versions. With SQL Server 2016 being the current version, released in June 1 and being supported only by x64 processors [2]. Here are some of the several edition Microsoft has released over the past years:

- Enterprise
- Standard
- Workgroup
- Express
- Azure
- Developer

3.1.1. *Command Line SQL*

The Command Line SQL (sqlcmd) is utility from the command prompt with which you can manage your Microsoft SQL Server. The sqlcmd utility is a command-line utility for ad hoc, interactive execution of Transact-SQL statements and scripts and for automating Transact-SQL scripting tasks. It is generally used in the following ways [6]:

- Users interactively enter Transact-SQL statements in a manner similar to working at the command prompt.
- Users submit a sqlcmd job either by specifying a single Transact-SQL statement to execute, or by pointing the utility to a text file that contains Transact-SQL statements to execute.
- SQLCMD mode in SQL Server Management Studio Query Editor.
- SQL Server Management Objects (SMO).
- SQL Server Agent CmdExec jobs.

3.1.2. *SQL Management Studio*

SQL Management Studio (SSMS) is a software application launched by Microsoft along with SQL Server 2005 and it is used for configuring, managing, and administering all components within Microsoft SQL Server [2]. SSMS is a workstation component\client tool that contains both script editors and graphical tools which work with objects and features of the server. An essential feature of SQL Management Studio is the Object Explorer, which enables the user to browse, select, and act upon any of the objects within the server [6]. In contrast with Command Line SQL, SSMS tool allows you to connect to and manage your SQL Server from a graphical interface instead of having to use the command line.

3.2. *Visual Studio*

Microsoft Visual Studio is an integrated development environment (IDE). It is used to develop applications with Windows Forms or WPF applications, web pages, web applications, web services, and also Windows Store apps both with native code and as well as managed code for every supported platform from Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .NET Compact Framework and the Microsoft Silverlight [2].

Visual Studio includes processing code supporting IntelliSense, as well as the refactoring code. The intergraded debugger works both as a source-level debugger and a machine-level debugger [9]. Every built-in tool include a designer for the creation of GUI applications, a web designer, a class designer and database schema designer. It accepts plug-ins that enhance the functionality at almost every level – like the inclusion of source control support (e.g. Git, SubVersion, Visual SourceSafe etc.) as well as the addition of new toolsets editors and visual designers for domain specific languages or toolsets for other aspects of the software development lifecycle (like the client Team Foundation Server: Team Explorer) [2]. Visual studio supports a variation of different programming languages, with the assistance of language services, which allow the code editor and debugger support (in different levels) for almost every programming language if provided a language specific service. Built-in languages are C/C++ (via Visual C++), VB.NET (via Visual Basic .NET), C# (via Visual #), and F#. Support for other languages such as Python, Ruby among other is available through language services installed separately. XML / XSLT, HTML / XHTML, JavaScript and CSS are also supported. Furthermore, there are Individual language-specific versions of Visual Studio which provide limited language services for the user: Microsoft Visual Basic, Visual J#, Visual C# and Visual C++. Microsoft offers “Express” versions of Visual Studio for free. Commercial versions of Visual Studio along with selected previous versions are available for free to students through Microsoft’s DreamSpark program.

3.2.1. *Architecture*

Visual Studio does not support every programming language, on the contrary the plugging functionality for languages as VSPackage. When installed, this feature is available as a service. IDE provides three services: SVsSolution, which provides the ability to list the projects and the solutions, SVsUIShell which provides windowing and UI functionality, and lastly the SVsShell which deals with registration of the VSPackages [6]. Moreover, IDE is responsible for coordinating and enabling communication between services. All the editors, designers, project types and other tools are applied as VSPackages. Visual Studio uses COM in order to grant access at VSPackages. Visual Studio SDK also includes Managed Pack Framework (MPF), which is a set of managed wrappers for COM-Interfaces that allows the packages to be written in every CLI compatible language. The services can then be consumed for the creation of other packages, which add functionality to IDE of Visual Studio. Support for other programming languages can be added with the use of a specific VSPackage named Language Service. A language Service defines different interfaces where the application VSPackage can implement to add support for various functions. Functions that can be added in that way include syntax coloring, statement completion, brace matching, parameter information tooltips, member lists and error markers for background. If the interface is implemented, the function would be available for the language. Language services are to be implemented on a per-language. The applications can reuse the code from the analysis program or the language compiler. Language services can be implemented either in native code or Managed code. For native code, they can be user either with native COM interfaces or with Babel Framework (part of Visual Studio SDK). For Managed code, MPF includes wrappers for managed language services creation [2]. Visual Studio does not support any source control support, but provides two alternative ways of source control systems that can be integrated with the IDE. Source Control VSPackage can provide your own custom UI interface [6]. In contrast, a plug-in source control using MSSCCI (Microsoft Source Code Control Interface) provides a set of functions which are

used for the implementation of different source control functions, with a standard user interface of Visual Studio. MSSCCI initially used at Visual SourceSafe with Visual Studio 6.0, but later offered through Visual Studio SDK. Visual Studio .NET 2002 which use MSSCCI 1.1 and Visual Studio .NET 2003 uses MSSCCI 1.2. Visual Studio 2005, 2008 and 2010, use MSSCCI Version 1.3, which added support for rename and delete propagation as well as asynchronous opening [2].

Visual Studio supports multitasking issues in its environment. Issues that use different registry hives to store their configuration state and differ from their APPID (ID Application). Instances start from an AppId-specific.exe who chose the APPID, defines the root hive and starts IDE. The VSPackages which are registered to an APPID integrate to other VSPackages with this application ID. Different versions of Visual Studio products use different AppIds [2].

3.3. Postman

To effectively develop any web api you will need a client application that allows you to quickly create http requests with the ability to specify all parts of the request (e.g. headers, body content, method etc.).

We used Postman and on top of a very slick client it was full feature. By logging in you can create and manage your own collections of requests, which are then saved in the cloud by the application. This tool helped us increase our productivity and easily debug some more complex features like token-based authentication.

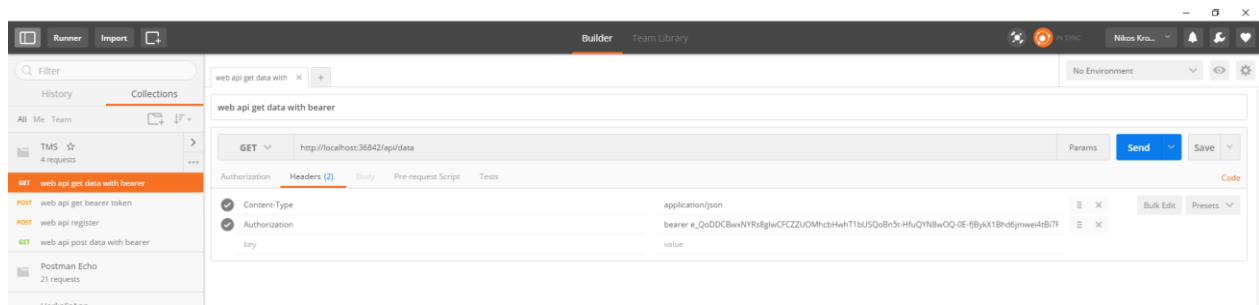


Figure 7: Postman [13]

3.4. IIS

Internet Information Services (IIS, former Internet Information Server) is an extensible web server which was created by Microsoft for Windows NT server operating systems. IIS supports protocols like HTTP, HTTPS, FTP, FTPS, SMTP and NNTP. It has become an integral part of the Windows NT family since the Windows NT 4.0, even though it may be absent in some versions (e.g. Windows XP Home version). IIS is disabled at Windows clean install. Management of IIS services is accessible through the Microsoft Management Console or through the Administrative Tools at Control Panel [2].

3.4.1. History of IIS

Microsoft First web browser a research program at the European Microsoft Windows Academic Centre (EMWAC), department of the Edinburgh University at Scotland, and distributed as a freeware. However, since the EMWAC server was not capable to scale in order to handle Microsoft.com traffic volume, Microsoft forced to develop their own web server, IIS [2].

Every IIS version before 7.0 which run in client operating systems can support only up to 10 different connections and a single web site. Almost every version of IIS was released either alongside or with a version of Microsoft Windows [2]:

- IIS 1.0 initially released as a free add-on for Windows NT 3.51.
- IIS 2.0 is included to Windows NT 4.0
- IIS 3.0, was included to Service Pack 2 of Windows NT 4.0, which introduced the Active Server Pages dynamic scripting environment.
- IIS 4.0 released as a part of the “Option Pack” for the Windows NT 4.0.
- IIS 5.0 released with Windows 2000 and introduced additional authentication methods, administration improvements, including the new MMC-based administration application, support of the WebDAV protocol and enhancements to ASP. In IIS 5.0 also the Gopher protocol was dropped.
- IIS 5.1 shipped with Windows XP Professional, and was almost identical to IIS 5.0 on Windows 2000.
- IIS 6.0, was included to Windows Server 2003 Windows XP Professional x64 version, IPv6 was added and included a new worker process model that increased the security as well as the reliability.
- IIS 7.0 was a complete redesign and rewrite and shipped with Windows Vista and Windows Server 2008. IIS 7.0 included a new modular design that allowed for a reduced attack surface and increased performance. Also, introduced a hierarchical configuration system allowing simpler website deploy, a new Windows management application, new command line management options and increased support for the .NET Framework. IIS 7.0 on Vista does not limit the number of connections, like IIS on XP, but limits the concurrent requests to 10(Windows Vista Ultimate, Business and Enterprise versions) or to 3 (Vista Home Premium). The additional requests are queued, impede performance but they are not rejected as it was with XP.
- IIS 7.5 is included to Windows 7 and at Windows Server 2008 R2. IIS 7.5 has improved WebDAV and FTP modules as well as command line in PowerShell. It also introduced TLS 1.1 and TLS 1.2 support, Best Practices Analyzer tool and isolation process of Application pools.
- IIS 8.0 is only available on Windows Server 2012 and Windows 8. IIS 8.0 includes the Application Initialization, centralized SSL certificate support and multicore scaling on NUMA hardware, among other new features
- IIS 8.5 is included on Windows Server 2012 R2 and Windows 8.1. This version includes Idle worker-Process page-out, Dynamic Site Activation, Enhanced Logging, ETW Logging and Automatic Certificate Rebind.
- IIS 10 is included in Windows Server 2016 and Windows 10. This version includes support for HTTP/2.

According to Netcraft, IIS is the second most popular web server in the world following the Apache HTTP Server. In the May 2016, the market share of IIS was 29.83%, with an increase of 6.14% that put Microsoft within 3 percentage points of Apache's leading market share of 32.8% [14].

4. The TMS system

4.1. Development Process

To design and develop the TMS system we have used Software Development Life Cycle (SLDC) and the Waterfall Model.

SDLC is a process followed for a software project, within a software organization. It consists of a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle defines a methodology for improving the quality of software and the overall development process [10].

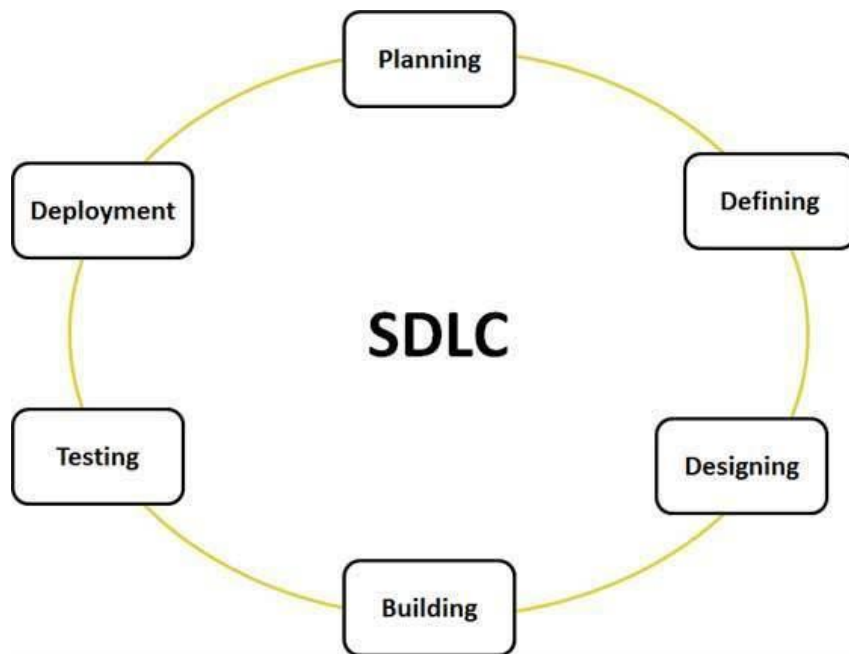


Figure 8: The stages of a typical SDLC [10]

The waterfall model is a sequential (non-iterative) design process, used in software development processes, in which progress is seen as flowing steadily downwards (like a waterfall) through the phases of conception, initiation, analysis, design, construction, testing, production/implementation and maintenance. Despite the development of new software development process models, the Waterfall method is still the dominant process model with over a third of software developers still using it [2].

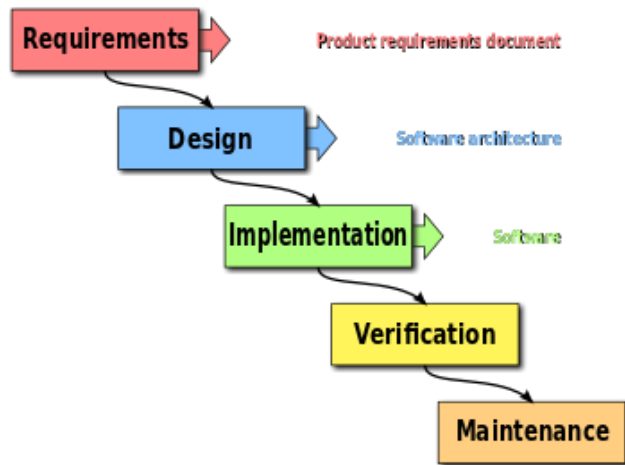


Figure 9: The waterfall model [2]

4.2. Specifications

To define the specifications of this product we consulted colleagues that have been working at a customer's facilities for big periods of time and managers that had to work with them from a distance. The main problem here was that the employees that worked in the customers' premises did not have access to the internet, imposed by the customer as a security measure. The company needed a lot and accurate data to correctly charge its customers because the customers' finance department would challenge every bill and the company's reputation was at stake.

This comes down to two main problems:

- Each employee had to write his time entries in any medium that he chose and then when he was back to the company somehow consolidate it with the data that the company had. Since an employee could be working out of office for many months the data would add up creating a big problem sharing this information with the company.
- The employees' notes usually only had the hours he/she worked and the customer. In some cases, it could have the project as well but it was mostly inconsistent. It was very difficult for the company's project managers and finance team to effectively do their job with so much missing and inconsistent data for their employee's work logs.

We need to improve the collaboration between all the stakeholders in the company (management, project managers, finance, and consultants). We also need to reduce the trust issues between them and improve the company's image as well. Appearance is very important when you are working at the customer, having every employee use a system instead of post-it notes will immensely help on that regard.

We are going to build a system that allows us to manage our projects and track our employees' time spent on each customer or project even if they work offline.

4.2.1. Main Elements:

- Website: The core part of the system, that should be used by every employee to manage their time entries and by every manager to have an overview of his team/projects. The focus of this module will be to consolidate the data, that all employees are adding, into one platform.
- Client with offline mode: This client app should make it easy for an employee to add his/her time spent on a day-to-day basis. It will respect the granularity required by the management. It will store

the time entries locally and automatically upload them once it detects that it can communicate with the server.

4.3. System Architecture

The system is based on a 3-tier architecture: On one end, we have the database layer which is responsible to store our business model. The database is not exposed to the internet it is only accessible from our web server which are the second tier of the system. In the web server, we handle all http requests and here we have almost all our application logic. Finally, we have the client layer where we have our JavaScript code executed in the context of a user agent (usually a web browser) and our WpfClient. WpfClient is working as a FAT client when it is in offline mode and as a thin client when it is in online mode. In online mode, it communicates with our webapi via http.

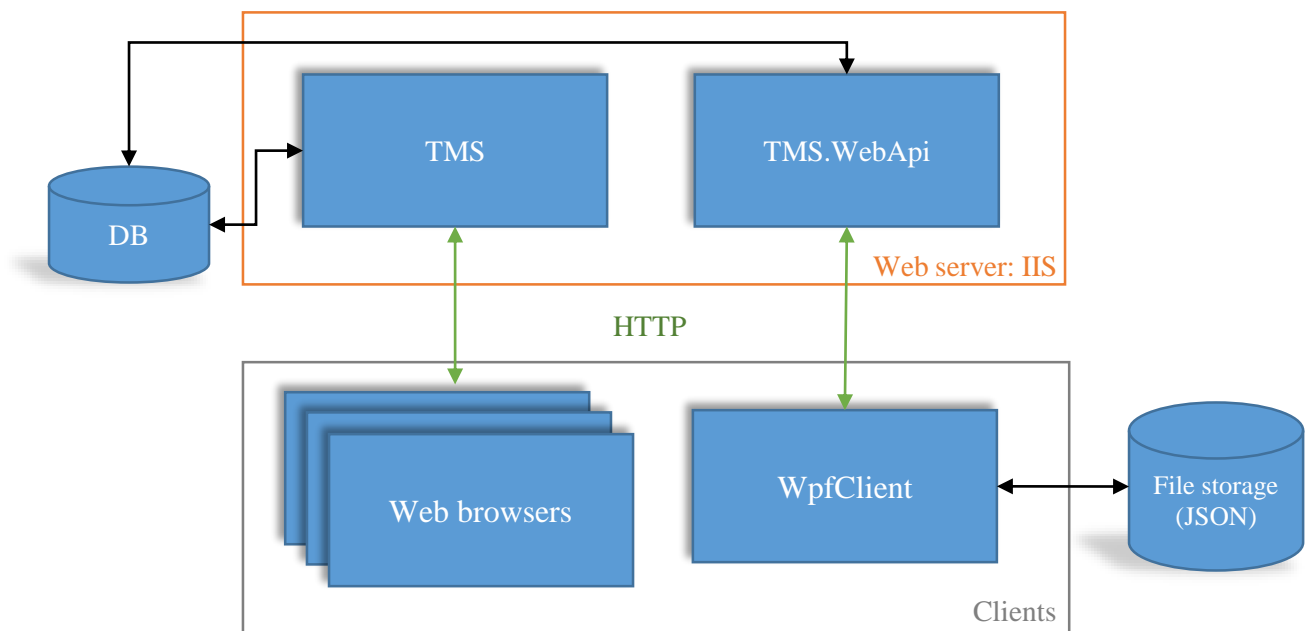


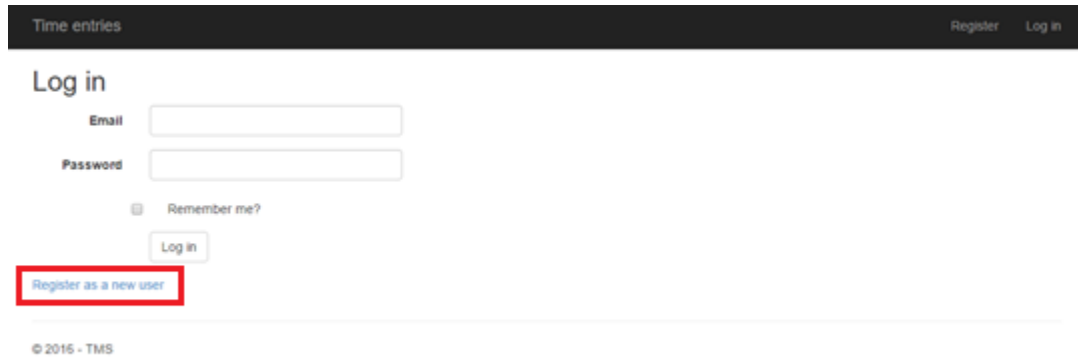
Figure 10: System architecture

4.4. Minimum System Requirements

- Windows Server 2008 R2
- IIS 7.5
- SQL Server 2012
- Disk Capacity at least 10Gb (Varies based on data stored)
- 4Gb of ram

4.5. Application workflow

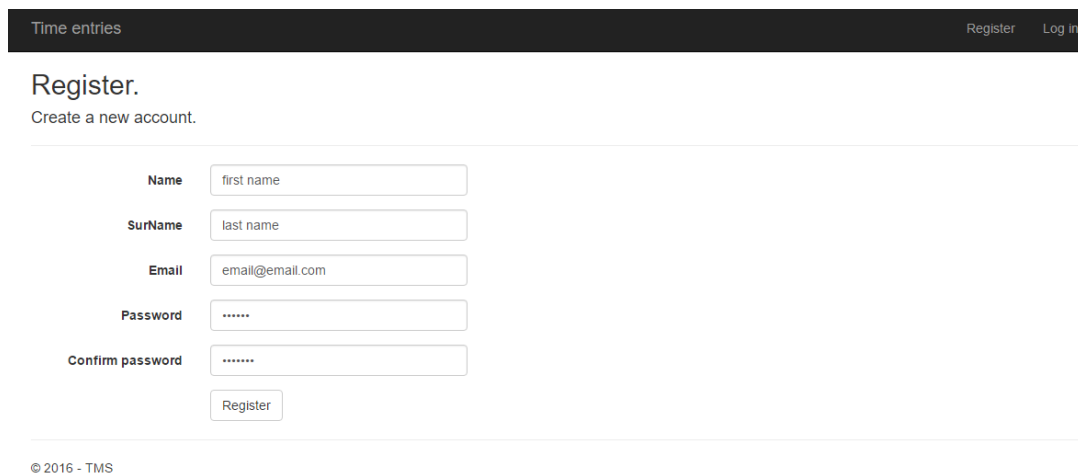
4.5.1. Register new user



The screenshot shows the login interface for a system. At the top, there is a dark header with the text "Time entries" on the left and "Register Log in" on the right. Below the header, the main content area is titled "Log in". It contains two input fields: "Email" and "Password". Below these fields is a checkbox labeled "Remember me?". A "Log in" button is positioned below the checkbox. At the bottom of the form, there is a link labeled "Register as a new user" which is highlighted with a red rectangular box. At the very bottom of the page, there is a copyright notice: "© 2016 - TMS".

Figure 11: Login view with Register link

To access the system, you need to have an account so every employee must register in the site. The start page is the login screen and there you can click the register button. In the login page we have the login form which requires the user to fill in the email and password. We don't have an account yet so we need to use the "Register as a new user" link at the bottom of the page to be redirected to the register use form.



The screenshot shows the registration interface. At the top, there is a dark header with the text "Time entries" on the left and "Register Log in" on the right. Below the header, the main content area is titled "Register." and has the subtitle "Create a new account." Below this, there is a form with five input fields: "Name" (with placeholder "first name"), "SurName" (with placeholder "last name"), "Email" (with placeholder "email@email.com"), "Password" (with placeholder "*****"), and "Confirm password" (with placeholder "*****"). A "Register" button is located below the "Confirm password" field. At the bottom of the page, there is a copyright notice: "© 2016 - TMS".

Figure 12: Register view

The register new user form requires some basic information from the user: Name, Surname, Email and Password. The user must fill in the form correctly and click the "Register" button.

Time entries Register Log in

Register.

Create a new account.

- The Name field is required.
- The SurName field is required.
- The Email field is required.
- The Password field is required.

Name

SurName

Email

Password

Confirm password

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Figure 13: Register view's validations

All the fields have validations on them (e.g. email must be a valid email, password must match the confirm password field and contain a letter, a capital letter, a symbol and a number).

Once the user has created his/her account he can start using the system.

4.5.2. Login

The default page of the site.

Time entries Register Log in

Log in

Email

Password

Remember me?

[Register as a new user](#)

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Figure 14: Login view

After logging in the user is redirected to the time entries view which lists only his own time entries.

Module	Project	Department	Customer	Date	
	Clearing	IT	AlphaBank	13/11/2016	Edit Details Delete
				21/11/2016	Edit Details Delete
	Margin Portfolios			21/11/2016	Edit Details Delete
				21/11/2016	Edit Details Delete
				21/11/2016	Edit Details Delete
M1	Clearing	IT	AlphaBank	21/11/2016	Edit Details Delete
M2				21/11/2016	Edit Details Delete

Showing 1 to 7 of 7 entries

Previous 1 Next

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Figure 15: Time Entries list view

In this view we have a data table [15] that supports sorting for all the columns. The table contains the following columns which correspond to the fields in our TimeEntry Business Object:

- Module
- Project
- Department
- Customer
- Date

We didn't include all the fields in our TimeEntry to make it more compact. The fields that are included can be used to easily find previous entries you have added.

Furthermore, the table has a pager at the bottom right and displays paging information at the bottom left.

Each row contains a column with the following action buttons: Edit, Details, Delete.

Edit: takes you to the edit page for that row where you can modify and save the entry.

Details: takes you to the details page for that row where you can see all the fields that the entry has.

Delete: takes you to the delete page for that row which is the same as the details but it has a delete button at the bottom. By using this you can delete a time entry.

At the top right, in the login section of the header you see the email of the logged in user and the button to log off and at the top left we have the navigation bar that includes links to navigate to section for managing all other business objects in the system.

4.5.3. Management of system data

To correctly use the system, you need to setup some initial data so that the time entries that will be added later will be associated to the appropriate customer/project.

The user should setup their projects and customers before any employee starts adding time entries. To do this the user can access any Business Entity from the navbar at the header of the site. For each one of them there is a list view that shows all entries for that entity and actions to add new, update or delete.

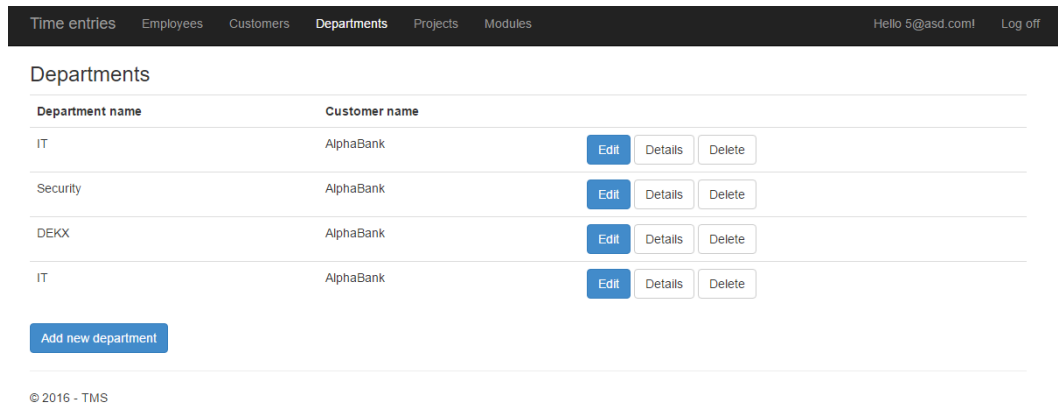


Figure 16: Departments list view

Some entities reference others using foreign keys in the database. (e.g. when you create a new department you see a dropdown for the customer field that enumerates all customers in the system.

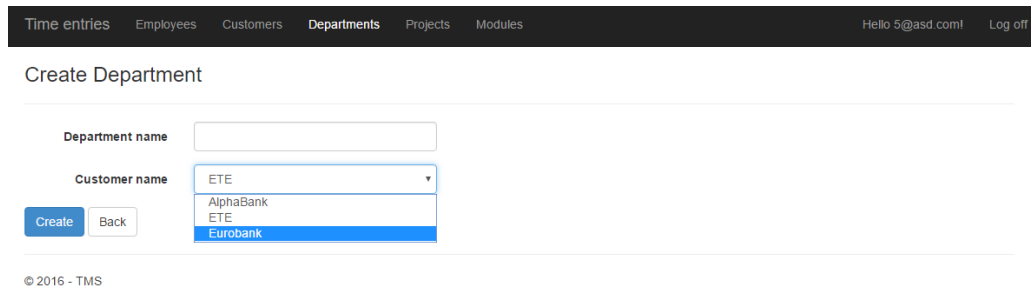


Figure 17: Add department view

4.5.4. Add a time entry

After logging in you land in the time entries list view which, in contrast to any other list view in the system, uses library to render the table. This list can grow very long over time and by using this library we have set up some much-needed features like paging and sorting.

Module	Project	Department	Customer	Date			
M1	Margin Portfolios	Security	AlphaBank	13/11/2016	Edit	Details	Delete
M2	LessThan50	DEXX	AlphaBank	09/11/2016	Edit	Details	Delete
	Clearing	IT		13/11/2016	Edit	Details	Delete
	Clearing		AlphaBank	21/11/2016	Edit	Details	Delete
	Clearing			24/11/2016	Edit	Details	Delete
M1	Clearing	IT	AlphaBank	13/11/2016	Edit	Details	Delete
M1	Clearing	IT	AlphaBank	13/11/2016	Edit	Details	Delete
M1	Clearing	IT	AlphaBank	13/11/2016	Edit	Details	Delete
				13/11/2016	Edit	Details	Delete
				13/11/2016	Edit	Details	Delete

Showing 1 to 10 of 34 entries

Previous 1 2 3 4 Next

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Figure 18: Time entries list view

Clicking on the ‘Add new entry’ button you go to the time entries’ creation form.

Time entries	Employees	Customers	Departments	Projects	Modules	Hello_email2@gmail.com	Log off
--------------	-----------	-----------	-------------	----------	---------	------------------------	---------

Create Time Entry

Module:

Project:

Department:

- Clearing
- Margin Portfolios
- LessThan50

Customer:

Date:

Start time:

End time:

Comments:

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Figure 19: Dropdown in add new time entry view

Here we need to display a datepicker and two timepickers so we used another external library, bootstrap-datetimepicker [16], which supports both modes. Aside from this, this form does not differ from any other

form in the system. It has validations and dropdowns showing a name instead of the id used to link the tables. The referenced tables here can be nullable so we have an extra entry in each dropdown for the null value.

Time entries Employees Customers Departments Projects Modules Hello_email2@gmail.com Log off

Create Time Entry

Module Please select...
Project Please select...
Department Please select...
Customer Please select...
Date 01/12/2016
Start time 10:08 AM
End time
Comments

10 : 08 AM

Create Back

© 2016 - TMS

Figure 20: Timepicker in add new time entry view [16]

4.5.5. WPF client

The workflow when using the WpfClient is mostly the same with that in the site. There are two big differences though:

1. The user does not have access to the system data, there is no way to modify them or create new entries for them.
2. When the WpfClient works in offline mode the user cannot login and he/she is allowed to view, and insert any time entries locally. All the changes will be uploaded automatically the next time that the client is started and it can communicate with the server.

The list view has a table that supports sorting but not paging.

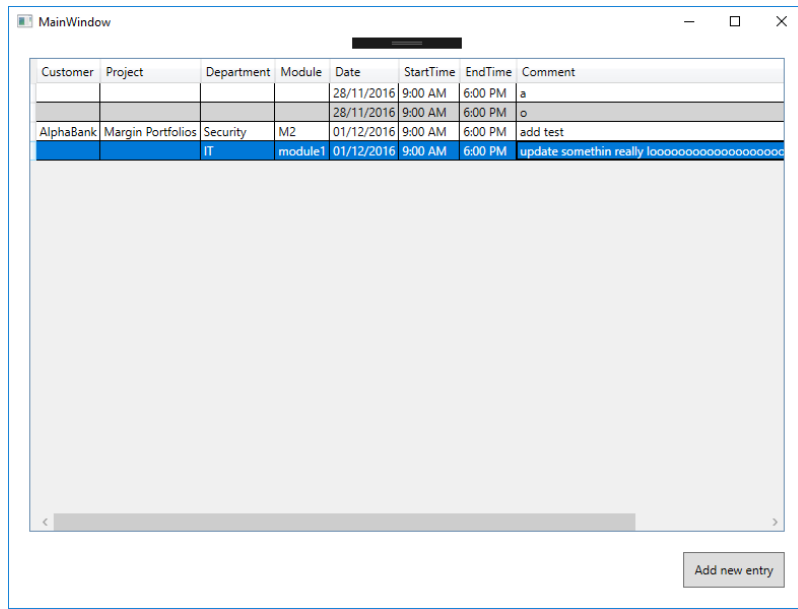


Figure 21: Time entries list (WPF)

The Add new entry form is functionally identical to the one in site.

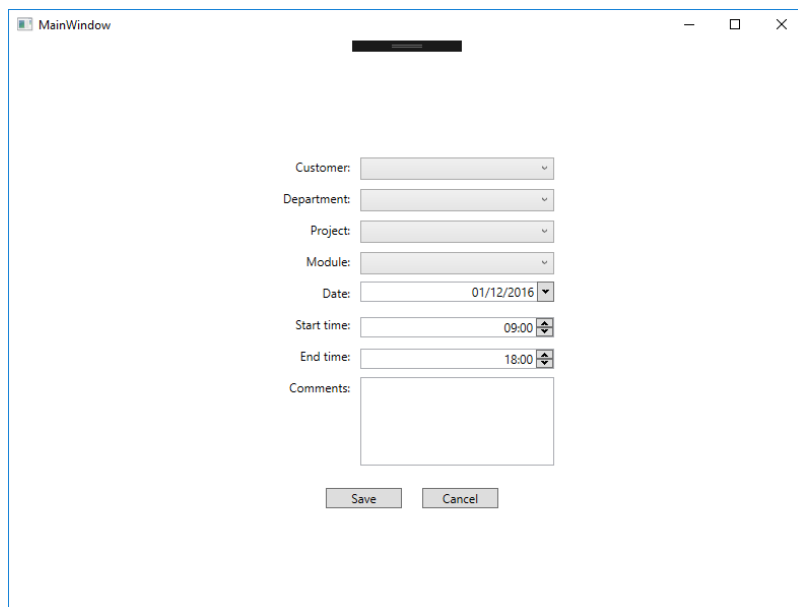


Figure 22: add time entry (WPF)

4.6. Implementation details

4.6.1. Business Model

There are some tables that are used by the default ASP.NET authentication module that comes with ASP.NET MVC 5:

- AspNetRoles

- AspNetUserClaims
- AspNetUserLogins
- AspNetUserRoles
- AspNetUsers

From which only *AspNetUsers* is used heavily by the application and stores the login information of the registered users.

Furthermore, we have the following tables that store the application data:

- Customer
- Department
- Project
- Module
- Employee
- TimeEntry

This is a visual representation of our Data Model:

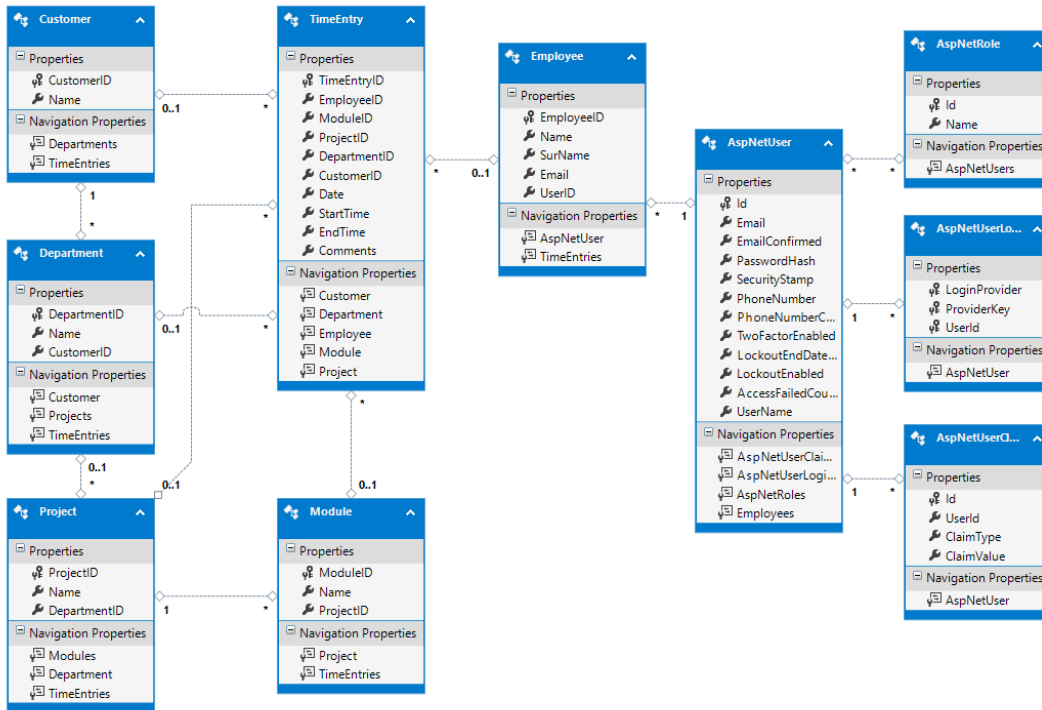


Figure 23: Data model

The model is defined in its own project (TMS.Model) so that it can be reused from its two consumers, TMS site and TMS.WebApi. We used a database-first approach and started our project from the database, thus we used Entity Framework to take advantage of its excellent model generation. Our main concern was that we may need to make many changes in the database during the kick off of our site. With Entity Framework, it is very easy to automatically refresh your C# classes base on the latest database schema.

4.6.2. ASP.NET MVC 5 Scaffolding

This is a very useful feature to jump start a project and quickly create a prototype. It allowed us to create the foundations for our website by taking care of all the boilerplate code that you need to setup your controllers, your views and how they are connected. Of course, there are a lot of things to be done afterwards in both the views (especially if you have to add client side code) and in the controllers to take care of the application behavior (e.g. redirects, workflow, authentication etc.).

4.6.3. ASP.NET MVC 5 Bundling

This is another feature that comes with ASP.NET MVC, it is responsible to serve bundles with the minified versions of our script (JavaScript) and style (CSS) files. Instead of using the default html tags to include them one by one explicitly, we define bundles in App_Start/BundleConfig.cs. To easily test this feature you can set the compilation tag in Web.config to **false**. (This is done automatically when you deploy the site to IIS). `<compilation debug="true" targetFramework="4.5.2" />`

In debug mode, bundling is disabled:

Name	Status	Type	Initiator	Size	Time	Timeline - Start Time	1.00 s ▲
Departments	200	docume...	Other	2.1 KB	23 ms		
bootstrap.css	200	stylesheet	Departments:7	20.1 KB	159 ms		
bootstrap-datetimepicker.min.css	200	stylesheet	Departments:8	1.7 KB	28 ms		
jquery.dataTables.min.css	200	stylesheet	Departments:9	2.4 KB	50 ms		
jquery.dataTables.min.js	200	script	Departments:138	27.9 KB	165 ms		
browserLink	200	script	Departments:149	58.8 KB	6 ms		
site.css	200	stylesheet	Departments:10	707 B	10 ms		
modernizr-2.6.2.js	200	script	Departments:12	16.2 KB	100 ms		
moment.min.js	200	script	Departments:132	12.0 KB	40 ms		
jquery-1.12.4.min.js	200	script	Departments:134	33.5 KB	94 ms		
bootstrap.min.js	200	script	Departments:136	9.4 KB	69 ms		
bootstrap-datetimepicker.min.js	200	script	Departments:140	16.0 KB	133 ms		
negotiateRequestUri=http%3A%2F%2Flocalhost%3A1809%2FD...&	200	xhr	browserLink:37	954 B	2 ms		
connect?transport=webSockets&connectionToken=AQAAANCM...	101	websoc...	browserLink:52	0 B	Pending		
db26b1bf30ab4939a4be8c2276d24e75?version=2	200	xhr	browserLink:37	2.8 KB	5 ms		

Figure 24: Network traffic (debug)

But in production it will be like this:

Name	Status	Type	Initiator	Size	Time	Timeline - Start Time	2.00 s ▲
Departments	200	docume...	Other	2.2 KB	2.08 s		
css?v=EUZapiBw766PjXBVRepPAKaC56Rz6udz-4aR9xBYTQ1	200	stylesheet	Departments:7	(from di...	5 ms		
modernizr?v=wBEWDufH_8Md-Pbioxomt90vm6UN2Pyy9u9zHT...	200	script	Departments:9	(from di...	2 ms		
moment?v=kkpPV5smqDQnRZYV_4kKH7bd_wY67-M3MipJ4fFP...	200	script	Departments:129	(from di...	4 ms		
jquery?v=JL596WEzEYSLK79KRL4itN63VxpRIW4A824KHhVLC1	200	script	Departments:131	(from di...	5 ms		
bootstrap?v=GDSp91DufYgT7_a41EbMqPMI_e_zrbw_UKHPxUlw...	200	script	Departments:133	(from di...	4 ms		
datatables?v=KmFREjmZVWHJWGif_K7JBZV7yQupWbLjE9MXfh...	200	script	Departments:135	(from di...	5 ms		
datetime?v=L8zokX2cYUv5YU10M0VqW5uF1qm98lvNa02ZboKZ...	200	script	Departments:137	(from di...	4 ms		

Figure 25: Network traffic (release)

Another useful feature that comes with bundling is that in debug mode you can use the full version of your scripts which you can then debug easily in your browser if needed. In production, the bundling mechanism will try to find a minified version of the file and use that instead (you should have side-by-side and add the suffix “.min”).

4.6.4. ASP.NET WebApi

Development in our webapi is based on the same principals as our website. There were a couple of interesting problems though.

Contrary to our website (that returns html in its responses), our web api returns our data in JavaScript Object Notation (JSON) format. This is on purpose as JSON is normally smaller in size than xml (although if you compress xml it is almost the same size with JSON) and it is very easy to be consumed in the javascript world which is a huge benefit if you want to be future-proof and to easily support more clients. Single page applications are thriving lately and frameworks like AngularJS or backbone.js are the norm.

The problem is that Entity Framework classes does not create plain old CLR objects (POCO). Classes are decorated with various attributes and include the related objects, based on the foreign keys in the database. This classes cannot be serialized to JSON because they have circular references with their related classes.

To overcome this problem, we have created data transfer objects (DTO) which are in fact POCOs and can be easily serialized to and from a JSON string. The problem now has been moved to the fact that Entity Framework needs its own classes to save in the database. Thus, we now needed a transformation layer.

AutoMapper [17] is another great library, it lets you create maps between two object types and then use this map to easily convert from one to the other, hassle-free and quite fast too.

```
var config = new MapperConfiguration(cfg =>
{
    cfg.CreateMap<TimeEntry, Models.TimeEntry>();
});

 IMapper mapper = config.CreateMapper();

var entries = mapper.Map<List<TimeEntry>, List<Models.TimeEntry>>(timeEntries.ToList());
return Ok(entries);
```

Figure 26: AutoMapper usage (code sample)

In this example, we are converting the objects that we retrieved from our database to our data transfer object which is then automatically serialized by the framework and is ready to be send back to caller.

4.6.5. WebApi Token-based authentication

We already explained the reasons for choosing a token-based authentication model over a cookie-based. Having a self-contained token has really helped us simplify our client side code. In our wpf project we have created a TokenManager singleton that takes care of everything related to authentication.

5. Conclusions

This is not the first .Net solution that we have created and we can say with certainty that the Microsoft platform is very capable when it comes to application development. With the .Net framework you have solutions for the whole stack of technologies any modern application may need. There are many components that work out of the box and it is the perfect environment to learn as you go, perfect match for beginners and experts alike. The framework has been through a facelift lately and a much needed one. It is now more open than ever and it can be bend as needed to follow the latest standards in the most highly accelerating areas of Software Development.

In our team, there were an experienced developer and a fresh one, and this project has been instrumental in sharing knowledge and finding our weaknesses by challenging already known concepts. We have both improved our knowledge and our skillset by working in this project and we are now better prepared to face real-world working environments.

6. Future work and Improvements

There are many aspects that can be improved in this solution and are not due to time constraints or lack of resources.

Entity framework is great to jump-start a project but there are a couple of problems that make it a less than ideal candidate for your de-facto solution for a Data Access Layer (DAL). It is less performant than any alternative that there is out there. It is an external library that restricts your area of control. It may have bugs (and it does) and you depend on others to fix them for you (which could potentially take years). External libraries are usually much harder to debug and the DAL is arguably the most sensitive part of any system, if you have a problem there you need to find it and fix it as soon as possible, losing your data may have huge repercussions. Not having POCOs by default is another missing nice-to-have feature. We would rather use a smaller library like Dapper, which is easily extendable, you have full control over the sql commands that you actually execute, you have the source code there in just one file and you still get the syntactic sugar that comes with LINQ.

The **business logic** is currently duplicated in both webapi and website. This is far from ideal and very hard to maintain. A more orthogonal approach would be to have the website serve a single page application that directly consumes your webapi ajax calls. The webapi already serves json data so it is ready for this. You could extract all the business logic in a separate project and have your webapi depend only on that project. That way you reduce the coupling between front facing platforms and our DAL.

We should have all **data transfer objects (DTOs)** in one place and every response from a webserver should be based on this model. In other words, we should completely decouple our database model from our webapi model. Our webapi model is our public contract to the world and it should use semantic versioning and any changes should be done with the appropriate consideration. Our database on the other hand is an internal implementation detail, which we may want to change very often in order to improve performance or support new features that are not exposed in our api.

Unit tests are missing from the system and this is arguably the biggest weakness of the system. Furthermore, we are exposing a public facing api which is not tested. Any regression will be invisible and will be exposed to our making breaking all our consumers. Having decoupled modules in our system would make it so much easier to test it.

Finally, we should **extend our authentication model** to include claims-based authorization. We can then assign claims to each user and make sure there is a hierarchy of privileges and a separation of roles. E.g. We could support a 'Manager' role that can access all information by other teams. Or even go to a finer granularity and give claims on data objects.

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