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Contract no.: 611875

D5.2

Initial Platform Prototype

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SYMPHONY Consortium

No	Name	Short name	Country
1	UNIVERSITA DEGLI STUDI DI GENOVA	UNIGE	Italy
2	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	ICCS	Greece
3	PlayGen Ltd	PlayGen	United Kingdom
4	GCF - GLOBAL CLIMATE FORUM EV	GCF	Germany
5	Athens Technology Center	ATC	Greece
6	UNIVERSITA POLITECNICA DELLE MARCHE	UNIVPM	Italy
7	INSTITUT JOZEF STEFAN	JSI	Slovenia
8	Germanwatch Nord-Sued-Initiative e.V.	GW	Germany
9	UNIVERSITAT JAUME I DE CASTELLON	UJI	Spain

Document History

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v.0.5	14-10-2015	Partners' review and comments	Efthimios Bothos, Niki Nikolakakou, Grigorios Mentzas (ICCS)
v.1.0	19-10-2015	Final Version	Nikos Dimakopoulos, Panagiotis Kokkinakis, Anna Triantafillou (ATC)

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Executive Summary

The SYMPHONY Platform aims at providing a set of innovative ICT tools, integrated in a dashboard designed to support policy experts and policy modelers in tackling problems referring to broad societal transitions including sustainable patterns of production and consumption. In particular, users of the platform can explore financial sector regulations and macroeconomic policies and acquire results that will help them to design the required policies which in turn will trigger sustainability transitions.

In this context, this document describes the initial integrated prototype of the SYMPHONY project. This version is the first working version of the prototype and will act as the testbed for the SYMPHONY stakeholders to experience with the SYMPHONY provisions, and assess the concepts and knowledge conveyed by the project.

The SYMPHONY Platform, far from being a simple container for the individual modules, is a coherent application, where several different components reside and collaborate in harmony. The first prototype is a proof of concept to the SYMPHONY end users. It encapsulates most of the underlying technologies and gives a clear and easy to use graphical interface, exposing every available feature so far.

The benefit of the current architecture is that any additional functionality can be wrapped into a separate component and be added to the platform, provided that it abides by the basic communication standards exposed by the SYMPHONY platform architecture. The scope of this practice is to keep the SYMPHONY prototype evolving and enable future extensions to arising functionalities, which may maximize the potentials for further exploitation and adoption of the platform beyond the project end.

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1 Introduction

The purpose of this document is to present the revised system architecture, the SYMPHONY system and the SYMPHONY initial platform prototype in terms of the user and technical requirements that realize it.

1.1 Purpose and Scope

The scope of this document is to examine the platform from two different aspects; from the technical point of view, in which the revised architectural structure is described, including its components, and from the end-user point of view, in which the external appearance, look-and-feel and the overall high level functionalities and interaction potentials are explained at the User Guide (Dashboard & Game) in Section 6.

1.2 Approach for Work package & Relation to other WPs & Deliverables

WP5 aims at providing the architectural and implementation aspects for the delivery of the SYMPHONY components integration in a unified platform. The design of the SYMPHONY platform is driven from the requirements definition in WP1.

Following the implementation of the individual modules in WP2, WP3 and WP4, this WP delivers an integrated view of the SYMPHONY platform to act as the testbed for building the SYMPHONY stakeholder use-cases in WP 6 and evaluating them in real life scenarios. Note that the decisions presented in this deliverable are subject to refinements and modifications, based on the progress of the technical work packages, as well as the validation and evaluation phases.

1.3 Structure of the Deliverable

This document reports on the initial activities and effort placed in the integration of the various technologies and tools towards delivering a functional SYMPHONY Integrated prototype. Following the SYMPHONY approach towards the policy making lifecycle, the integration effort is guided from the Agile Software Development methodology, aiming to progress the development work in parallel teams and regularly integrating their output, based on a well-defined design.

The scope of this document is to act as appendix to the current version of the SYMPHONY integrated prototype and, as such, it is structured as follows:

- Section 2 provides an overview of the updated SYMPHONY architecture, highlighting the revisions made with respect to [7]. It briefly describes the SYMPHONY components and the updated data description of SYMPHONY's components.
- Section 3 provides the physical architecture of SYMPONY Initial platform.
- Section 4 describes the testing framework that has been followed for the technical evaluation of the initial version of SYMPHONY platform.

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- Section 5 presents the process that has been followed for the implementation of SYMPHONY's platform UI.
- Section 6 provides the user guides with the main functionality of SYMPHONY's Dashboard and Gamification.
- Section 7 describes the Security and Privacy requirements/aspects that have been adopted for the project.
- Finally, Section 8 concludes this report and presents the next steps for the final integration of the SYMPHONY integrated platform.

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2 System Architecture

2.1 Architecture Diagram

The SYMPHONY platform architecture was revised based on the architecture design presented in D5.1 [7]. The software components that are being analyzed in the following present an overview of the environment and the software components of the SYMPHONY platform along with the communication lines. These communication lines show the interaction of the SYMPHONY components with the actors of the platform i.e. Citizens, Policy makers, Policy modelers, Administrators etc. The communication between the actors and the SYMPHONY dashboard/game is made through a web browser while the internal software component communication is handled using RESTful web services. The revised version of the logical view representation of the SYMPHONY architectural design is presented at the below figure. The revision of the logical view mostly concerns the SYMPHONY Platform front-end and services where a single point of access supports both dashboard and game UIs.

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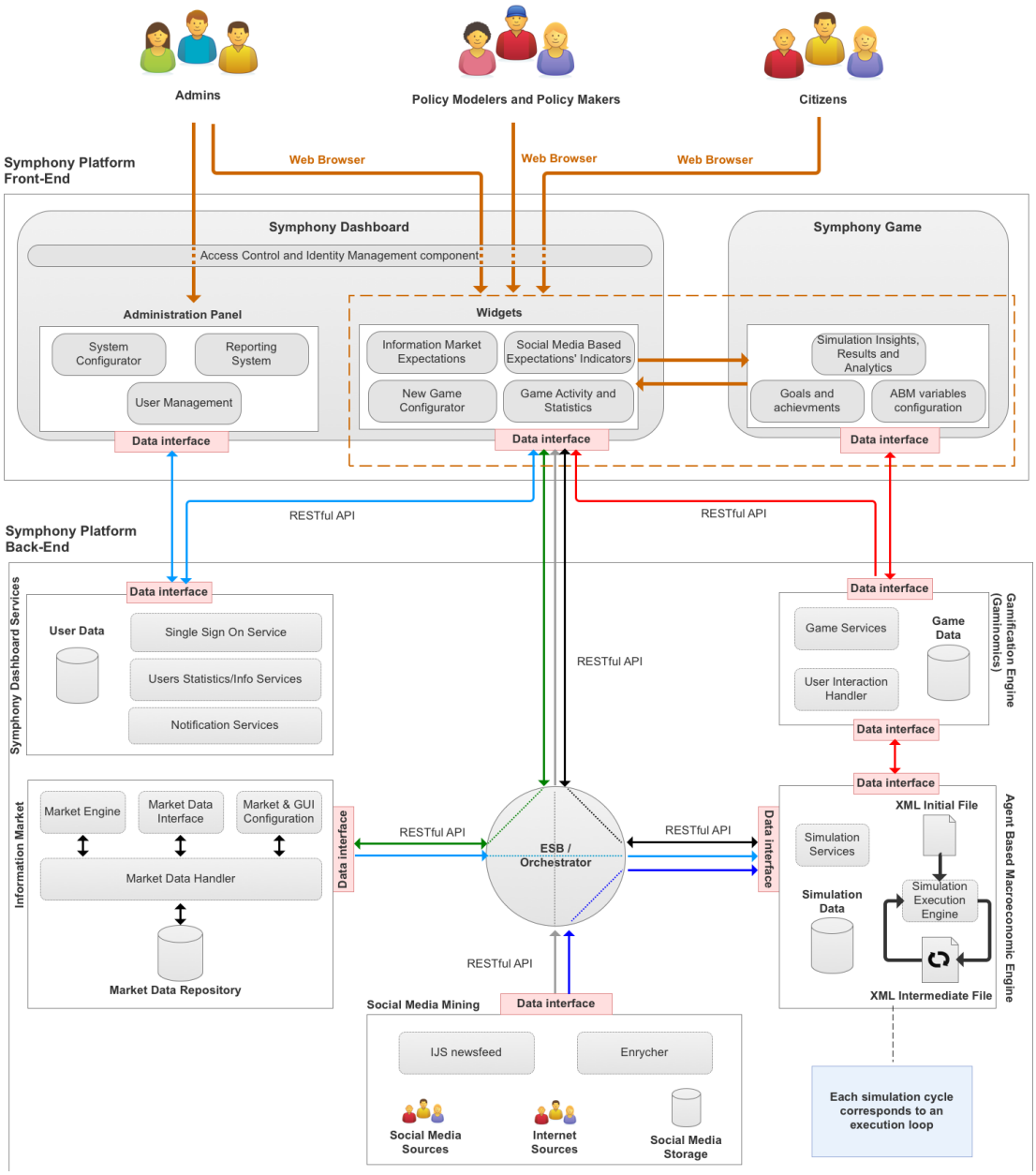

Figure 2-1: A logical view representation of the revised SYMPHONY architectural design

2.2 SYMPHONY Components

Since the architecture of the SYMPHONY platform has been revised, the components comprising the platform are briefly described in the following paragraphs with the needed updates. As these components have a detailed description in terms of technology and functionality in separate deliverables of WP2, WP3 and WP4, only a short description update of D5.1 [7] is presented in this section in order to help the reader understand the architecture and physical diagrams. Pointers to the respective deliverables have been added to the relevant components.

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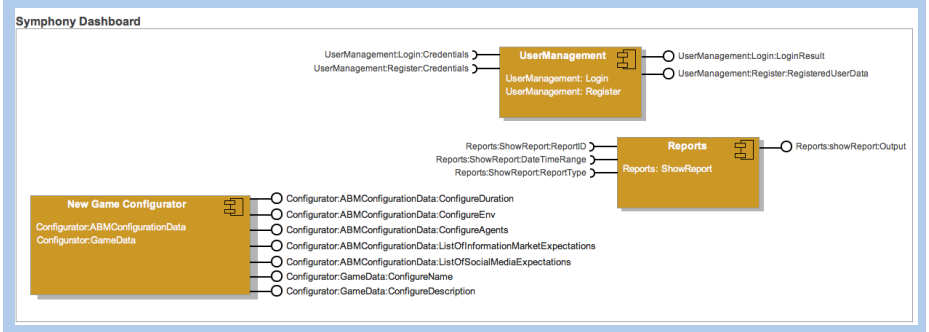
	SYMPHONY Dashboard		
Description	The SYMPHONY Front-End is the SYMPHONY Dashboard that contains the Widgets and the Administration Panel. The SYMPHONY Dashboard constitutes the main access gateway for participants (Citizens, Policy modelers, Policy makers and Administrators) to the SYMPHONY platform. Using a web browser, Citizens, Policy modelers and Policy makers can interact with the Widgets, while Administrators can interact with the Administration Panel, set configuration parameters and access the reporting system. Figure 2-4 provides an overview of the SYMPHONY Front-End elements.		
TRL [1]	**Before project Start** 0	**Aimed For Y2** 4	**Aimed For Y3** 8
Architecture/ **Technologies Used**	The SYMPHONY Dashboard aims to integrate information from multiple and heterogeneous components into a single and unified display. It is available as a web interface and thus all participants are able to access it using any modern web browser. The look and feel is unified for all participants but the interfaces and the data presented vary, depending on the role each participant has in SYMPHONY platform. For example a Citizen won't be able to access neither the system configurator nor the reporting system. To access these two restricted areas, a user must have an administrator role. The below UML class diagram of the SYMPHONY Dashboard component describes its structure by showing the classes, the attributes and the operations (or methods).  Figure 2-2: UML Class diagram of the SYMPHONY Dashboard The table at section 2.2.1.1 presents the analysis of the Dashboard data description that states the name, the brief description and the Implementation priority of the Data Interfaces, the external methods that are available to other components, as well as the input and output parameters of the Dashboard.		

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User Interaction

Widgets

Widgets are the most prominent part of the SYMPHONY framework for the sole reason that they are the only gate to the end users.

Widget elements are tightly integrated into the SYMPHONY Dashboard. The widgets are built using HTML 5 and are enriched with live data using AJAX calls to data providers (Information Market [IM], Social Media Mining [SMM], ABM Engine [ABM]). The main idea is to provide information regarding the gamification elements (ie. rewards) that will motivate the end users to participate to the SYMPHONY game.

In terms of data communication, the data providers (IM, SMM, ABM) and the widgets are using RESTful services.

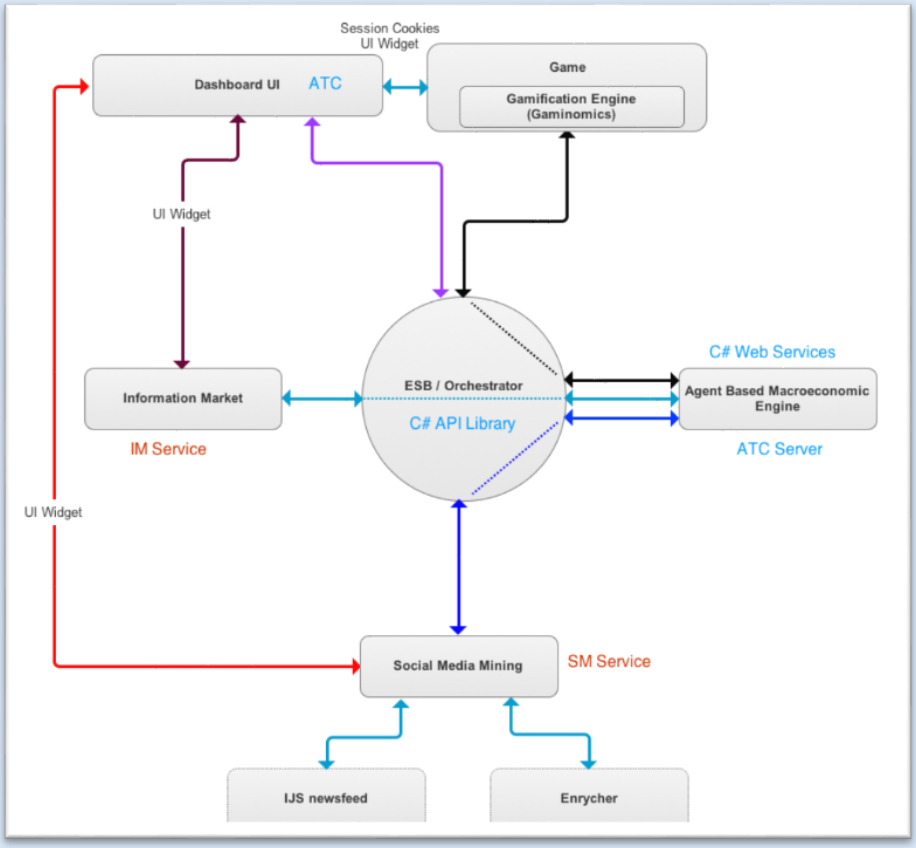

Figure 2-3: SYMPHONY architecture (abstract)

Administration Panel

The Administration panel consists of two sub areas (Figure 2-4), the System Configurator and the Reporting System. The access to the Administration panel is limited to users with Administrator role. Also the Administration panel is used to initiate component variables, configure system behavior as well as access usage and statistical reports.

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	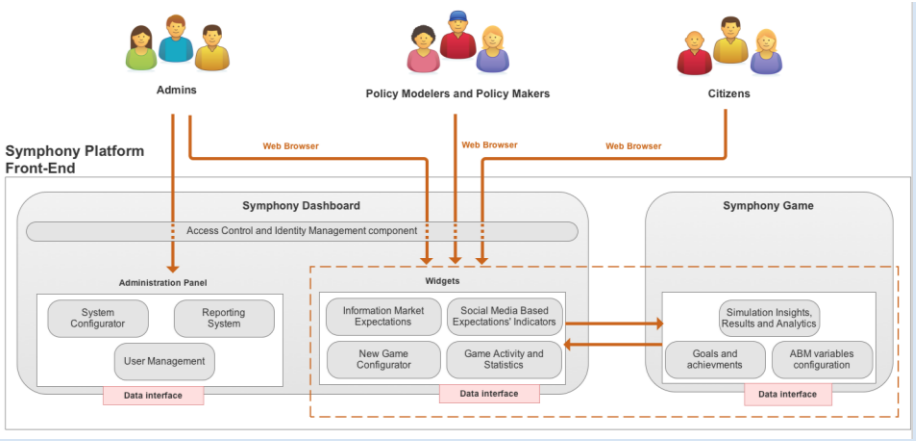 Figure 2-4: SYMPHONY Frond-end
Partners Involved	ATC
Reference Files	Related Deliverable: D5.1 [7]

Table 1: SYMPHONY Dashboard

Access Control and Identity Management	
Description	SYMPHONY platform is based on WordPress [1] and it uses industry standard, government-grade encryption technologies, including advanced algorithms such as DES, MD5 and Blowfish. It offers a customizable single sign-on (SSO) that integrates with its internal users' database. Furthermore, SYMPHONY platform ships with robust user management and security features including advanced password policies, user reminder settings, and complete log-in security procedures. Other security features include: • Email Verification • Session Management • Logout user from all locations The SYMPHONY Access Control and Identity Management System will heavily rely on these security features of WordPress. Being developed as WordPress plugins, the deployed components will be easily configured by the administrators in order to match the access policy.

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TRL [1]	Before project Start	Aimed For Y2	Aimed For Y3
	9	9	9
Architecture/ Technologies Used	The SYMPHONY security features are applied system-wise, covering all layers of architecture. This component ensures that only users with appropriate permissions are able to access the data relying in the platform's services and data storage. Moreover, the external APIs (Service Interfaces) exposed by the platform can be secured by means of encryption over HTTP via SSL, which is the standard protocol for security over the Internet. Since we are using WordPress for the SYMPHONY platform, user credentials (for accessing the central platform) are stored encrypted inside the WordPress database, the database is accessible only by direct access to the WordPress server. Only the Services Layer and the UI is exposed publicly. Finally, we are not going to store sensitive data inside the platform (e.g. credit card details or users' financial data).		
User Interaction	Following the approach for implementing the platform, the following user interactions are presented: Access control A common requirement of most multi-user information systems is to provide a mechanism for access control. Access control comprises identification, authentication and authorization. By providing insecure access control mechanisms in SYMPHONY, registered users, advanced users, and administrators might be able to access information of other users in the system. Furthermore, an attacker might get access to the SYMPHONY platform, which would enable him to use data that are not publicly available, misconfigure system settings or gain access to services like advanced data insights. Security pattern-based access control Security patterns are a well-established domain within the IT-security field. Security patterns describe well-proven security solutions for common IT-security problems. They are written by security experts in their respective domains. To implement access control in SYMPHONY, a combination of security patterns is required. At the SYMPHONY platform it has been implemented by using a security patterns of access control mechanism. By implementing the "Single Access Point" pattern, only a one point of access needs to be secured. The "Checkpoint" pattern provides the framework for implementing the required authentication and authorization patterns and its		

[1] 1 to 9 with 9 being the most mature technology. See more at https://en.wikipedia.org/wiki/Technology_readiness_level

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	enforcement. Relying on a security pattern approach, the insecure access control risk can be mitigated as only authorized users have access to the SYMPHONY platform. Moreover, a secure access control mechanism also indirectly mitigates the risk for identity theft as only the authorized users have access to services and protected data. Furthermore, it prevents data leakage, as all data stored in the SYMPHONY platform is only available to authorized users.
Partners Involved	ATC
Reference Files	https://wordpress.org/support/

Table 2: Access Control and Identity Management

	ABM Engine		
Description	Large scale multi-country model of the economy based on the agent-based methodology. The local interaction of heterogeneous agents causes the emergence of macroeconomic regularities (bottom up approach).		
TRL [1]	**Before project Start** 5	**Aimed For Y2** 6	**Aimed For Y3** 7
Architecture/ Technologies Used	The component is an economic model programmed in FLAME[2] which is a technology based on C code and explicitly designed for agent based programming.		
User Interaction	Simple users can access the agent based models via the SYMPHONY Gamification by playing the role of an agent (firm, bank, government), i.e., controlling an artificial agent by taking dynamic and interactive decisions. Moreover, advanced users have access to some analytic tools and can use the information market and social media mining tools in order to gather information to set up and initialize new games.		
Partners Involved	UNIGE, UJI, UNIPM, ATC		
Reference Files	Related Deliverable: D3.2 [5]		

Table 3: ABM Engine.

[1] 1 to 9 with 9 being the most mature technology. See more at https://en.wikipedia.org/wiki/Technology_readiness_level

[2] http://www.flame.ac.uk

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<table>
<tr><th colspan="4">Gamification</th></tr>
<tr><td>Description</td><td colspan="3">The Gamification component is the interface of the gamification layer of SYMPHONY project. It consists of the role-playing game, where players take on the role of agents within an ABM simulation, making decisions that affect the rest of the simulation, including other players.

The user interacts with the game via the gamification interface. Built using web-standard technology, the interface includes menus, buttons, interactive graphs and popup modals, (among others) which come together to provide an integrated, immersive gaming experience.

 
</td></tr>
<tr><td>TRL [3]</td><td>Before project Start
0</td><td>Aimed For Y2
5</td><td>Aimed For Y3
9</td></tr>
<tr><td>Architecture/ Technologies Used</td><td colspan="3">Back End:

Symphony gamification backend is written using Microsoft C# on top of .NET 4.5 framework and uses Entity Framework 6 as a middleware to communicate with Database. A few of the major backend gamification components are authentication (with SSO), historical data storage and goals management.

The Game front end communicates with the back end using RESTful JSON APIs. When a request is received by the game back end, an API</td></tr>
</table>

[3] 1 to 9 with 9 being the most mature technology. See more at https://en.wikipedia.org/wiki/Technology_readiness_level

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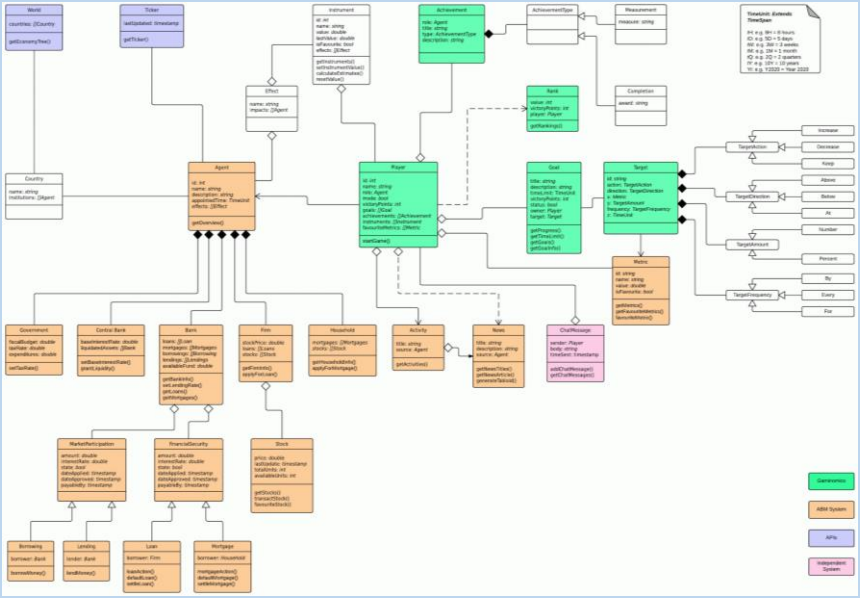
call is made to a SSO system that has been provided by ATC. The response from the SSO is then validated and translated into an appropriate format, data is stored and updated in the database and then transmitted back to the front end. Although the authentication process involves several API calls (in order to avoid any security compromise) over TCP/HTTP, the whole transaction takes very little time thanks to use the of asynchronous HTTP calls provided by ASP.NET's *HttpClient* module. This quick speed is vital to providing a fast, and responsive experience for the players.

See the below figure that presents Game's back-end architecture.



Front End:

The front end portion of the SYMPHONY gamification was primarily built using AngularJS, a JavaScript based MVC (Model-View-Controller) framework made by Google. Whilst Angular is a JavaScript based framework, the SYMPHONY gamification front end was written using CoffeeScript, a language that compiles to JavaScript, allowing for 100% library support. The code is pre-compiled to JavaScript, and then minified in order to reduce the size of the files and, in turn, loading time.

The structure of the front end was separated based upon the *panels* in the design. Each panel has a view (to control how things are shown), a controller (to control what is shown), and a service (to access relevant data from the back end). Some panels shared services, such as the News service being used by both the sidebar panel and the news page. This structure can be seen in Figure 2.

For the appearance, we used Twitter Bootstrap, a popular open

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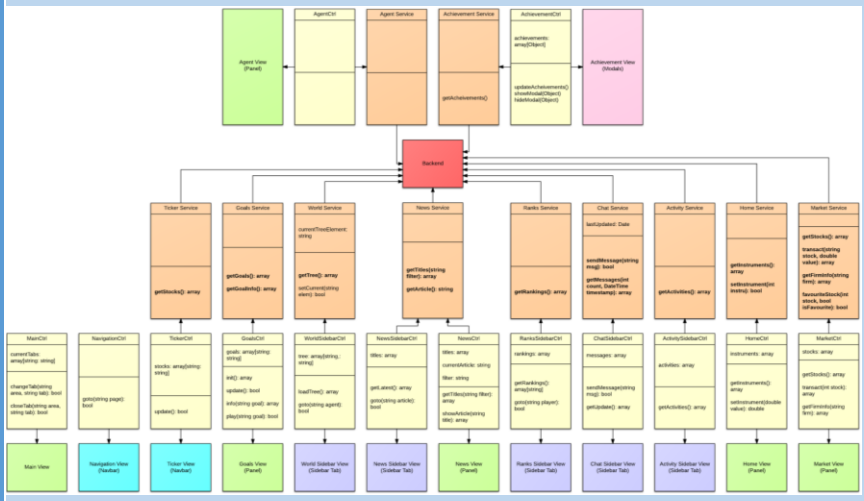
	source HTML/CSS framework, which includes some extra components that came in useful for Symphony (e.g. accordions, modals, etc). The style for the Front End was primarily handled by the Symphony *policy maker* Twitter Bootstrap theme. Written in LESS, and compiled to CSS, this theme overwrites the default Bootstrap styles, whilst still following standard Bootstrap convention. This means that the themes can be switched and changed around, without needing to make any changes to the markup. See the below figure that presents Game's front-end architecture. 
User Interaction	**Login** Login, registration and general user management is managed by ATC's dashboard. Once user is logged in and is eligible to play game, dashboard will redirect to particular URL hosting a game. After receiving, communicating and validating session data with ATC SSO system user is logged in to the system with particular player role. **Communication with Orchestrator & Data Storage** Most of communication is done with the help of wrapper function library provided by ATC. Received data is then passed through gamification layer and historical variables are asynchronously stored in database. In further stages these data is used in conjunction with various game components. **Government Player Agent Screen** Government is responsible for the fiscal and welfare policies. The income of the government is given by corporate tax, Value-added tax, capital income tax (dividends and bond coupons) and labour tax. The

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	tax payments are done by firms, capital producers, banks and households and the government budget income is calculated as the sum of all tax payments. Taxes are collected on a monthly basis, while tax rates are revised yearly. Regarding government's expenditures, they include wages for households employed in the public sector, that are set as fixed percentage of the total households, unemployment benefits, transfers and repayment of the government debt (bond coupons). The government observes its budget balance (payment account Mg) every month and if Mg < 0 the government has a budget deficit which can be financed by issuing new government bonds, which are sold to the households. The Government computes its budget deficit once per month, but enters the bond market on a daily basis. The reason is that if the Government enters in the bond market only once per month there is insufficient demand for the bonds, so the Government may fail to attain its liquidity target. Thus the monthly budget deficit will be financed by bonds on a monthly basis, but there is a smoothing across the month. **Central Bank Player Agent Screen** The central bank is the responsible for the monetary policy. It sets the policy rate, which is the cost of liquidity provided to banks. The short-term nominal interest rate follows the Taylor where π is the yearly inflation rate for a current month, $\tilde{\pi}$ is the desired rate of inflation, υ is the unemployment rate for a current month, and $\bar{\upsilon}$ mimics the natural rate of unemployment, or the full-employment rate (that we exogenously set to 0 for simplicity). This version of the Taylor rule departs from the standard one for its use of the unemployment rate instead of the output. The two measures are strongly interconnected and the unemployment gap is certainly a satisfactory indicator of economic recession. Another role of the central bank is the provision of a standing facility to grant liquidity in infinite supply to commercial banks, when they are in short supply.
Partners Involved	PlayGen, ATC, UNIGE
Reference Files	Help text & Policy effects: https://docs.google.com/spreadsheets/d/11_1hQeO8dCp7s6ZcYv7eColSm00DBOU_jjYQRVm7VKE/edit#gid=0

Table 4: Gamification

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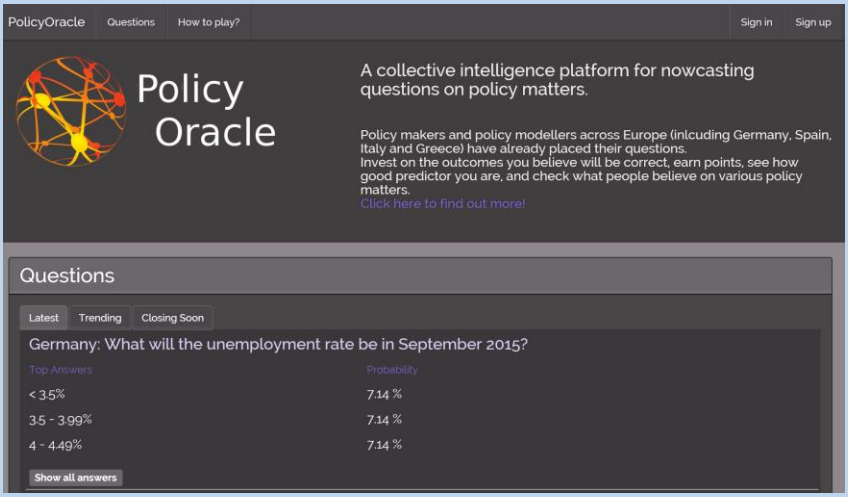
Information Market (IM)	
Description	Information Markets (IMs) are speculative markets that serve to aggregate the beliefs of multiple traders in the price of contracts representing different outcomes of a future event. Contract prices provide a reasonable estimate of what the traders in aggregate believe to be the probability of the event and as such markets are able to generate forecasts. Individuals influence these prices by buying and selling contract shares based on their belief about the outcome. At the end of the dealing period, individuals are paid off based on the accuracy of their bids. In SYMPHONY we have developed an IM which is called PolicyOracle. The PolicyOracle information market is developed for the purpose of collecting and aggregating expectations from experts and interested stakeholders. PolicyOracle is a thin client web application comprised of three layers: data, business logic and presentation. The presentation layer includes the information architecture, as well as the main displays of the tool while the business logic layer contains the main processing functionalities. The application was implemented with fast prototyping techniques using the Ruby on Rails web application framework and in close cooperation with SYMPHONY's economists and policy modelers.  **Figure 2-5: The landing page of PolicyOracle. Basic information and an overview of the available questions is provided in this page.**

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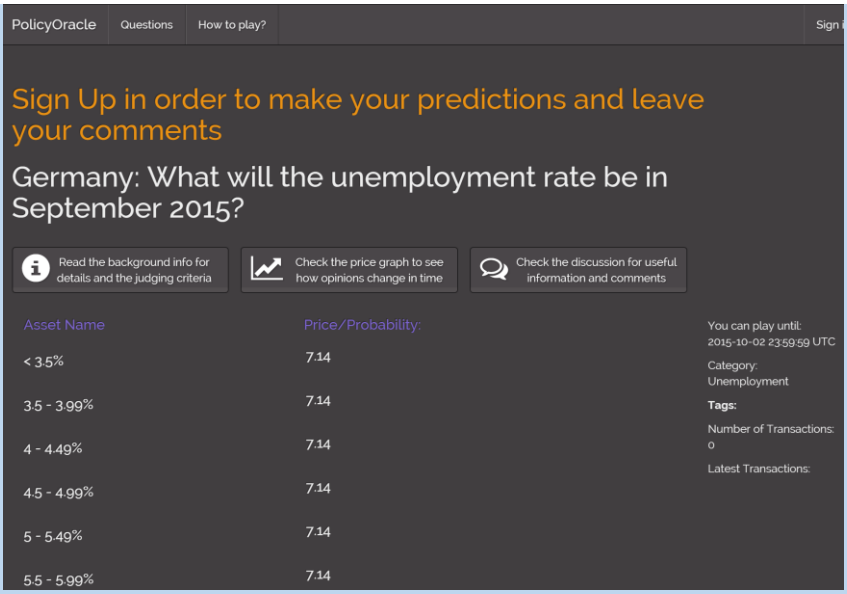

Figure 2-6: Indicative view of a question. Users participate by selecting one of the available answers and buying or selling shares of that answer.

TRL [4]	Before project Start	Aimed For Y2	Aimed For Y3
	2	4	6

Architecture/ Technologies Used

Figure 2-7 depicts the PolicyOracle's functional architecture. The system comprises of three tiers loosely coupled with each other.

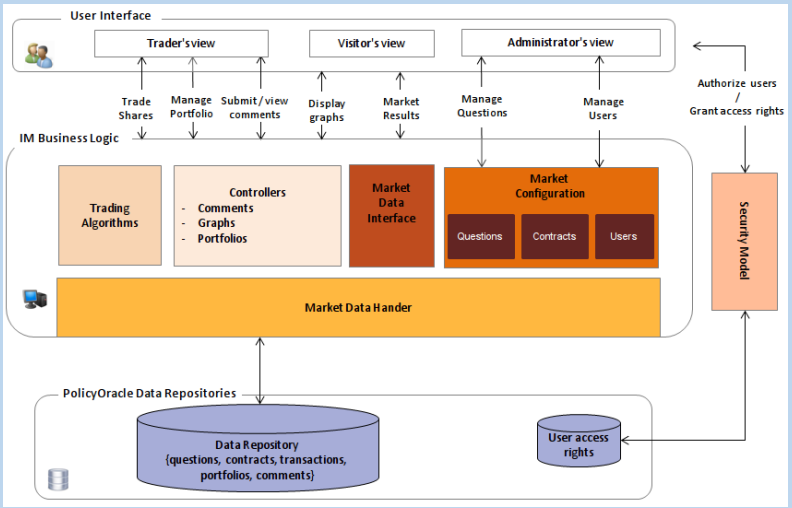

Figure 2-7: The PolicyOracle IM Architecture

At the top level we place the modules that are relevant to the user interface. We distinguish the Administrator's view, the Trader's view

[4] 1 to 9 with 9 being the most mature technology. See more at https://en.wikipedia.org/wiki/Technology_readiness_level

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	and the Visitor's view according to the different roles that will have access to different functions of the system. The IM Business Logic exists in the middle layer of the system. We have placed here the core functions and operations. The market operating functions mainly handle trading actions, offering features that are mainly addressed to the administrator to manage the information market. The third layer comprises of the data repositories that are required for the information market operation.

User Interaction	The API implemented in PolicyOracle provides access to the following functionalities:
	- Markets management which includes the following methods:
	  o Aggregated expectations
	  o List of contracts in a market
	  o List of open markets
	  o Edit market
	  o New Market
	- Transactions processing which offers the functionality to submit a new transaction on behalf of the user and includes the following methods:
	  o new transaction
	- Users management which offers functionalities to perform operation on user data and retrieve user related information with the following methods:
	  o create user
	  o user balance history
	  o user current holdings
	  o user markets
	  o user points
	  o user shares
	  o user trade history

Partners Involved	ICCS
Reference Files	A detailed description of PolicyOracle is provided in SYMPHONY Deliverable D2.3 [4]

Table 5: Information Market

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<table>
<tr><th colspan="4">Social Media Mining (SMM)</th></tr>
<tr><td>Description</td><td colspan="3">Social Media Mining Component

Social Media Mining refers to data mining of content streams produced by people through interaction via Internet based applications.

The Social Media Mining Component developed within SYMPHONY project performs a number of activities that will allow us to observe, enrich and store data from social media, as well as analyze how social medial signals align with macroeconomic trends.

The core of the SMM Component will include the following functionalities:

- Observing subcomponent, which will receive data from social media.
- Enrichment subcomponent, which will perform enrichment of social media data.
- Storage subcomponent, which will handle storage and access to social media data.
- Modeling subcomponent, which will provide models for correlation with and nowcasting of macroeconomic indicators based on signals from social media.
- Application Programming Interface provides partner applications or widgets with access to the data and methods implemented.
- User Interface module provides an easy to use interface for people (e.g. policy makers) to the implemented functionality (correlate, nowcast).</td></tr>
<tr><td>TRL [5]</td><td>Before project Start

1</td><td>Aimed For Y2

7</td><td>Aimed For Y3

9</td></tr>
<tr><td>Architecture/ Technologies Used</td><td colspan="3">- The Social Media Collector collects tweets and pushes them to the annotator service;
- The Social Media Annotator performs sentiment extraction and URL normalization;
- The Storage and Querying component stores tweets and their annotations and enables querying and aggregation;</td></tr>
</table>

[5] 1 to 9 with 9 being the most mature technology. See more at https://en.wikipedia.org/wiki/Technology_readiness_level

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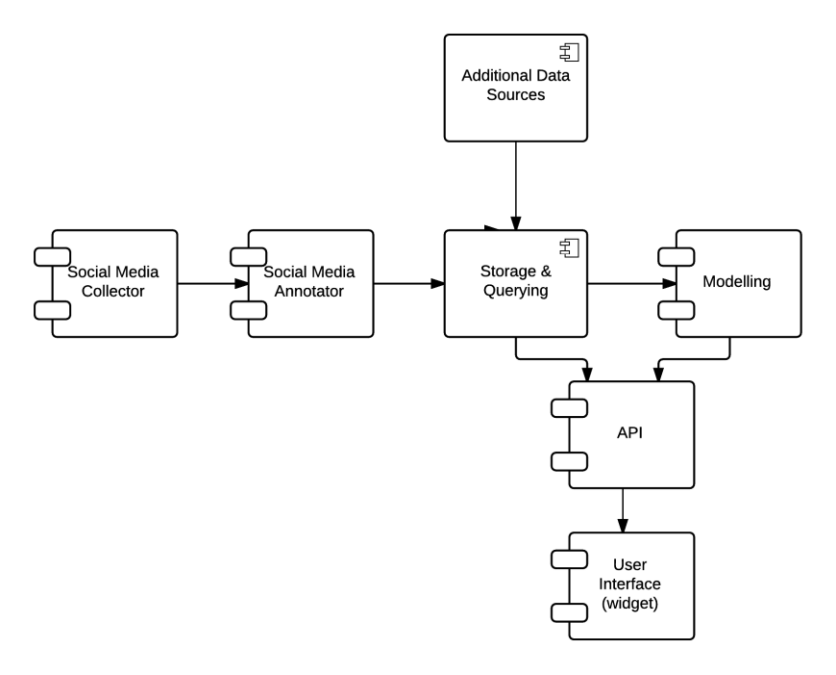
	- The modelling component performs correlation and nowcasting; - The Application Programming Interface is used to provide access to interfaces and other applications; - The user interface exposes functionality to the end user. 
User Interaction	Given a time series, either uploaded or builtin (e.g. macroeconomic variable) find correlated signals in social or traditional media and/or nowcast the variable. Plots graphs. Allows manual context reduction.
Partners Involved	JSI
Reference Files	Deliverable D2.2 [3] and Event Registry Correlate[6]

Table 6: Social Media Mining

2.2.1 Data Description (Revision)

All software components defined in SYMPHONY Architecture consist of various sub-components that perform specific tasks and expose inputs and outputs that are used to exchange data between them. In this section the revised data communication schema that comes from the D5.1 is presented in detail. The inputs and outputs have been revised and are analyzed exposing the hidden information they contain, composing a more complete view of the data exchange scene of the various sub-components. Below the data schema is presented grouped by the main software components.

[6] http://eventregistry.org/correlate

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2.2.1.1 Dashboard

Data Interfaces			
Name	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
WidgetHandler	Handles UI HTML widgets, provides methods to add or remove a widget from the dashboard etc	Must	Not Started
New Game Configurator	Used to configure a new Game, setting the initial variables	Must	Finished
Reports	Reporting system used to inform the administrators about system usage statistics and simulation statistics	Must	Finished
UserManagement	Used to manage all SYMPHONY users from simple players to system admins	Must	Finished
Methods (External)			
InterfaceName:MethodName	Brief Description	Implementation priority (Must/Should)	Implementation Status (Not Started, In Progress, Finished)
WidgetHandler:AddWidget	Adds a new widget to the SYMPHONY Dashboard	Must	Not Started
WidgetHandler:RemoveWidget	Removes an existing widget from the SYMPHONY Dashboard	Must	Not Started
Configurator:ABMConfigurationData	Configure or set one or more parameters regarding the Game module	Must	Finished
Configurator:GameChallenges	Configure or set one or more parameters regarding the Game module	Must	Not Started
Reports:ShowReport	Construct and show the requested report to the user	Should	Finished
UserManagement:Login	Used to login to SYMPHONY dashboard using user credentials	Must	Finished
Usermanagement:Register	Used to register a new user providing user info	Must	Finished

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Input			
InterfaceName:MethodName:InputParameterName	Brief Description	Implementation priority (Must/Should)	Implementation Status (Not Started, In Progress, Finished)
WidgetHandler:AddWidget:PositionID	ID of the position that the new widget will be placed	Must	Not Started
WidgetHandler:AddWidget:WidgetCode	The code to initialise the widget	Must	Not Started
WidgetHandler:RemoveWidget:PositionID	ID of the position to remove the widget from	Must	Not Started
Reports:ShowReport:ReportID	ID of the report to be displayed	Should	Finished
Reports:ShowReport:DateTimeRange	Datetime range for the report's data	Should	Finished
Reports:ShowReport:ReportType	Report type	Should	Finished
UserManagement:Login:Credentials	Credentials provided to login at SYMPHONY platform	Should	Finished
UserManagement:Register:Credentials	User data provided to register at SYMPHONY platform	Should	Finished
Output			
InterfaceName:MethodName:OutputParameterName	Brief Description	*Implementation priority (Must/Should)*	*Implementation Status (Not Started, In Progress, Finished)*
Reports:ShowReport:Output	The output result of the requested report	Must	Finished
UserManagement:Login:LoginResult	Result providing information regarding the login attempt	Should	Finished
UserManagement:Register:RegisterUserData	Result providing information regarding the registration attempt	Must	Finished
Configurator:ABMConfiguratorData:ConfigureDuration	Configuration data that are input to the ABM software component	Must	Finished
Configurator:ABMConfiguratorData:ConfigureEnv	Configuration data that are input to the ABM software component	Must	Finished

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Configurator:ABMConfiguratorData:ConfigureAgents	Configuration data that are input to the ABM software component	Must	Finished
Configurator:ABMConfiguratorData:ListOfInformationMarketExpectations	Configuration data that are input to the ABM software component	Must	In Progress
Configurator:ABMConfiguratorData:ListOfSocialMediaExpectations	Configuration data that are input to the ABM software component	Must	In Progress
Configurator:GameChallenges:ConfigurationData	Configuration data that are input to the Game software component	Must	Not Started
Configurator:GameData:ConfigureName	Configuration data that are input to the Game software component	Must	Finished
Configurator:GameData:ConfigureDescription	Configuration data that are input to the Game software component	Must	Finished

2.2.1.2 Gamification Engine (GE)

Data Interfaces			
Name	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Activity	Provides base structure for storage of various system activities	Should	In Progress
Agents	Structure of all agents and returns formatted data also stores historical variables for various agents	Must	Finished
Chats	In-Game communication between players	Optional	Not Started
Economy	Primary entity of game, also a translating interface between orchestrator and game.	Must	Finished
Favourites	User's personal preferences on which agent(s) they like	Must	Finished
Goals	Target & achievements that helps user to track their progress during game and provide collaborative environment	Must	Finished
Session	Facilitates user logins and game persistence	Optional	Finished
Simulation	Handles all game simulations and user interactions	Must	Finished
Statistics	Simulation's date and other secondary analytical data	Should	In Progress

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Stock	Base interface for *EuroStats* market	Should	In Progress
User	Primary entity of game, can participate as various agent type during game session	Must	Finished

Methods

InterfaceName:Method Name	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Activity:GetAllActivity	Get all the activities	Must	Finished
Agents:GetAllAgents	Get all the agents with formatted data	Must	Finished
Agents:GetAgentVariableHistory	Get all the historical data of an agent's variable	Must	In Progress
Agents:UpdateVariable	Update an agent's variable	Must	Finished
Chat:GetChatMessages	Get all the chat messages	Optional	Not Started
Chat:AddChatMessage	Add a message to the chat	Optional	Not Started
Economy:GetCountries	Get all the countries of the economy	Must	Finished
Favourites:GetFavourites	Get all the favorite variables of the user	Must	Finished
Favourites:AddFavourite	Add a variable to the favorites of the user	Must	Finished
Favourites:RemoveFavourite	Remove a variable from the favorite of the user	Must	Finished
Goals:GetUserGoals	Get the goals of the user	Must	Finished
Goals:GetAllGoals	Get all the goals	Must	Finished
Goals:GetGoal	Get the information of a goal	Must	Finished
Goals:CreateGoal	Create a new goal	Must	Finished
Goals:UpdateGoal	Update a goal's information	Must	Finished
Session:CreateSession	Create a session for user	Should	Finished
Session:RemoveSession	Remove a session for user	Should	Finished
Simulation:Init	Start a simulation	Must	Finished
Simulation:SaveCurrentState	Save all the data of each agents after simulation	Must	Finished
Simulation:NextCycle	Go to next simulation cycle	Must	Finished

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Statistics:GetStatistics	Get the statistics of the simulation and user	Optional	In Progress
Stock:GetAllStocks	Get the stock values	Optional	In Progress
User:GetUser	Get the user information	Must	Finished
User:Login	Login a user	Must	Finished
User:Logout	Logout a user	Must	Finished

Input			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Agents:GetAgentVariableHistory:Agent	Agent information	Must	In Progress
Agents:GetAgentVariableHistory:Variable	Variable information	Must	In Progress
Agents:UpdateVariable:Variable	Variable name, id and new value	Must	Finished
Chat:AddChatMessage:User	User information	Optional	Not Started
Chat:AddChatMessage:Message	Message content and time	Optional	Not Started
Favourites:GetFavourites:User	User information	Must	Finished
Favourites:AddFavourite:User	User information	Must	Finished
Favourites:AddFavourite:Agent	Agent information	Must	Finished
Favourites:RemoveFavourite:User	User information	Must	Finished
Favourites:RemoveFavourite:Agent	Agent information	Must	Finished
Goals:GetUserGoals:User	User information	Must	Finished
Goals:GetGoal:GoalId	Id of the goal	Must	Finished
Goals:CreateGoal:User	User information	Must	Finished
Goals:UpdateGoal:User	User information	Must	Finished
Goals:UpdateGoal:GoalId	Id of the goal	Must	Finished
Goals:UpdateGoal:GoalParams	Data of the goal	Must	Finished
Session:CreateSession:User	User information	Should	Finished
Session:RemoveSession:User	User information	Should	Finished

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Session:RemoveSession:SessionId	Id of the session	Should	Finished
Simulation:Init:GameId	Id of the game session	Must	Finished
Simulation:SaveCurrentState:GameId	Id of the game session	Must	Finished
Simulation:NextCycle:GameId	Id of the game session	Must	Finished
Statistics:GetStatistics:User	User information	Optional	In Progress
Statistics:GetStatistics:GameId	Id of the game session	Optional	In Progress
Stock:GetAllStocks:GameId	Id of the game session	Optional	In Progress
User:GetUser:UserId	User information	Must	Finished
User:Login:GameId	Id of the game session	Must	Finished
User:Logout:GameId	Id of the game session	Must	Finished
User:Logout:UserId	User information	Must	Finished
Output			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Activity:GetAllActivity:List<Activity>	List of all the *Activity*	Must	Finished
Agents:GetAllAgents:List<Agent>	List of all the *Agents*	Must	Finished
Agents:GetAgentVariableHistory:List<AgentHistory>	List of *AgentHistory* objects containing variable data	Must	In Progress
Agents:UpdateVariable:Variable	Updated variable data	Must	Finished
Chat:GetChatMessages:Collection<User, List<Message>>	Collection of users and their message data	Optional	Not Started
Chat:AddChatMessage:Message	Data of the added message	Optional	Not Started
Economy:GetCountries:List<Country>	List of all the Countries of the Economy	Must	Finished
Favourites:GetFavourites:List<Favourite>	List of the Favorite objects containing the favorited variables for the user	Must	Finished
Favourites:AddFavourite:Favourite	Data of the added Favorite	Must	Finished
Favourites:RemoveFavourite:*<True/False>*	Boolean to true if it succeed or false if it failed	Must	Finished

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Goals:GetUserGoals:List<Goal>	List of all the Goals for the User	Must	Finished
Goals:GetAllGoals:Collection<User, List<Goal>>	Collections of all the Goals associated to their User	Must	Finished
Goals:GetGoal:Goal	Data of the Goal	Must	Finished
Goals:CreateGoal:Goal	Data of the created Goal	Must	Finished
Goals:UpdateGoal:Goal	Data of the updated Goal	Must	Finished
Session:CreateSession:Session	Data of the new Session for the User	Should	Finished
Session:RemoveSession:<*True/False*>	Boolean to true if it succeed or false if it failed	Should	Finished
Simulation:Init:GameInfo	Current states information of the initialized game	Must	Finished
Simulation:SaveCurrentState:GameInfo	Current states information of the game	Must	Finished
Simulation:NextCycle:GameInfo	Current states information of the game after a new simulation cycle	Must	Finished
Statistics:GetStatistics:Simulation	Simulation information and statistics for the user	Optional	In Progress
Stock:GetAllStocks:List<StockInfo>	List of Stock variables' data	Optional	In Progress
User:GetUser:UserInfo	Information from the User	Must	Finished
User:Login:UserInfo	Information from the User	Must	Finished
User:Logout:<*True/False*>	Boolean to true if it succeed or false if it failed	Must	Finished

Table 7: Gamification Engine Data Description

2.2.1.3 Information Market (IM)

Data Interfaces			
Name	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Markets	Provides access to management of markets.	Must	***Finished***
Transactions	Provides functionalities to process transactions.	Must	***Finished***
Users	Provides functionalities for user data management.	Must	***Finished***

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Methods			
InterfaceName:MethodName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Markets: Aggregated expectations	Nowcasts expectations on macroeconomic indices and energy prices by providing the current market prices of corresponding IM contracts	Must	***Finished***
Markets: List of contracts in a market	Lists the contracts in a market	Must	***Finished***
Markets: List of open markets	Lists the open markets	Must	***Finished***
Markets: edit market	Edit market details	Must	***Finished***
Markets: new market	Creates a new market	Must	***Finished***
Transactions: new transaction	Processes a new transaction	Must	***Finished***
Users: create user	Creates a new user	Must	***Finished***
Users: user balance history	Provides the balance history of the user (questions which have been answered and the corresponding profits/ losses).	Must	***Finished***
Users: user current holdings	Provides the current holdings of the user.	Must	***Finished***
Users: user markets	Provides the markets the user has created.	Must	***Finished***
Users: user points	Provides the points the user holds.	Must	***Finished***
Users: user shares	Provides the shares a user holds of a contract.	Must	***Finished***
Users: user trade history	Provides the trade history of the user.	Must	***Finished***

Input			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Markets: Aggregated expectations:	Market id for nowcasting	Must	***Finished***

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market_id			
Markets: List of contracts in a market: market_id	Market id to list contracts	Must	***Finished***
Markets: edit market: id	id of the market to edit	Must	***Finished***
Markets: edit market: name	Edited market name	Must	***Finished***
Markets: edit market: category	Edited market category	Must	***Finished***
Markets: edit market: description	Edited market description	Must	***Finished***
Markets: edit market: arbitration_date	Edited market arbitration_date	Must	***Finished***
Markets: new market: email	Email of user creating the market	Must	***Finished***
Markets: new market: name	New market name	Must	***Finished***
Markets: new market: category	New market category	Must	***Finished***
Markets: new market: market_type	New market type	Must	***Finished***
Markets: new market: description	New market description	Must	***Finished***
Markets: new market: published_date	New market published date	Must	***Finished***
Markets: new market: arbitration_date	New market arbitration date	Must	***Finished***
Markets: new market: contracts_attributes	New market contracts attributes	Must	***Finished***
Transactions: new transaction: email	Email of user creating the transaction	Must	***Finished***
Transactions: new transaction: quantity	Transaction quantity	Must	***Finished***
Transactions: new transaction: transaction_type	Transaction type	Must	***Finished***
Transactions: new transaction: contract_id	Transaction contract id	Must	***Finished***
Users: create user: email	Email of new user	Must	***Finished***
Users: create user: name	Username of new user	Must	***Finished***
Users: user balance history: email	Email of user to retrieve balance history	Must	***Finished***
Users: user current holdings: email	Email of user to retrieve current holdings	Must	***Finished***
Users: user points: email	Email of user to retrieve current points	Must	***Finished***

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Users: user shares: email	Email of user to retrieve current shares	Must	***Finished***
Users: user trade history: email	Email of user to retrieve trade history	Must	***Finished***
Output			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Markets: Aggregated expectations: expectations	Nowcasted expectations for the market	Must	***Finished***
Markets: List of contracts in a market: current_price	Current price of contract	Must	***Finished***
Markets: List of contracts in a market: name	Contract name	Must	***Finished***
Markets: List of open markets: id	Market id	Must	***Finished***
Markets: List of open markets: name	Market name	Must	***Finished***
Markets: List of open markets: description	Market description	Must	***Finished***
Markets: List of open markets: category	Market category	Must	***Finished***
Markets: List of open markets: arbitration_date	Market arbitration date	Must	***Finished***
Markets: List of open markets: tenant	The tenant where the market resides	Must	***Finished***
Markets: edit market: result	Result of edit market operation	Must	***Finished***
Markets: new market: result	Result of new market operation	Must	***Finished***
Transactions: new transaction: result	Create transaction operation result	Must	***Finished***
Users: create user: name	Username of new user	Must	***Finished***
Users: create user: total_amount	Total amount of points of the new user	Must	***Finished***
Users: create user: tenant	Tenant where the new user belongs	Must	***Finished***
Users: user balance history: id	Balance history id	Must	***Finished***

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Users: user balance history: profit	Profit for the current entry	Must	***Finished***
Users: user balance history: created_at	Current entry creation date	Must	***Finished***
Users: user balance history: contract	Corresponding contract	Must	***Finished***
Users: user balance history: market	Market where the contract belongs	Must	***Finished***
Users: user current holdings: id	Id of holding	Must	***Finished***
Users: user current holdings: market	Market of current holding	Must	***Finished***
Users: user current holdings: holding	The details of the holding	Must	***Finished***
Users: user markets: id	Id of the market	Must	***Finished***
Users: user markets: name	Name of the market	Must	***Finished***
Users: user markets: category	Category of the market	Must	***Finished***
Users: user markets: arbitration_date	Arbitration date of the market	Must	***Finished***
Users: user markets: tenant	Tenant where the market belongs	Must	***Finished***
Users: user points: cash_amount	Points the user has	Must	***Finished***
Users: user points: current_holdings	Worth of current holdings	Must	***Finished***
Users: user points: total_amount	Sum of cash and current holdings	Must	***Finished***
Users: user shares: id	Holding share id	Must	***Finished***
Users: user shares: quantity	Quantity of the shares	Must	***Finished***
Users: user shares: amount_spent	Amount spent to buy the shares	Must	***Finished***
Users: user shares: contract	Contract the shares refer to	Must	***Finished***
Users: user shares: market	Market the shares refer to	Must	***Finished***
Users: user trade history: id	Trade history id	Must	***Finished***
Users: user trade history: contract	Trade history contract	Must	***Finished***
Users: user trade history: market	Trade history market	Must	***Finished***

Table 8: Information Market Data Description

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2.2.1.4 Social Media Mining (SMM)

Data Interfaces			
Name	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Storage	Stores data from Social media. Provides a list of query functionalities: search by hashtags, search by keywords, aggregations by different features, such as sentiment, frequency etc.	Must	Finished
Modeling	Learns models for nowcasting using SVM or linear regression to model time series from social media data.	Must	In Progress
Widgets	Provides access to the SMM functionalities through widget based interfaces	Could	Finished

Methods			
InterfaceName:MethodName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Modeling:Nowcasting	Nowcasts macroeconomic values (or any other time series provided)	Must	Finished
Storage:Query_Data	Query Data	Should	In Progress
Storage:Aggregates	Compose Aggregates (sentiment aggregates, timeline aggregates etc.)	Should	Finished
Modeling:Correlate	Correlation between social media signals and time series (e.g. macroeconomic variabiales)	Could	Finished
Widgets:SMM	Provides graphs that display nowcasting /correlation data	Could	Finished

Input			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In***

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			Progress, Finished)
Modeling:Nowcasting:MacroVariable	Macro variable for nowcasting	Must	Finished
Storage:Query_Data:SocialMediaDataQuery	Query (hashtags, users, keywords, date, location etc.)	Should	In Progress
Storage:Aggregates:QueryAggregates	Query for aggregate (keywords, hashtags, users etc.). Can also querry by time, location, or name of aggregates (like sentiment, volume etc.)	Should	In Progress
Widgets: SMM :WidgetData		Could	Finished
Output			
InterfaceName:MethodName:ParameterName	***Brief Description***	***Implementation priority (Must/Should)***	***Implementation Status (Not Started, In Progress, Finished)***
Modeling:Nowcasting: NowcastedMacroVariableValue	Macro variable nowcasted value. Output data is in Json	Must	Finished
Storage:Query_Data: DataQueryOut	Query output - social media data with specific hashtags, keywords, dates, location etc. In Json.	Should	In Progress
Storage:Aggregates: AggregateOut	Social media data aggregated by DateTime. In Json.	Should	In Progress
Widgets:SMM:WidgetOutput	SMM widget output (for instance, a graph showing the MacroVariable fluctuation).	Could	Finished

Table 9: Social Media Mining Data Description

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3 Physical Architecture

The physical structure of the SYMPHONY initial prototype is demonstrated in Figure 3-1 below. There are two main levels of components with the lowest level containing the servers and the operating system of the platform and the highest one with the WordPress framework upon which the SYMPHONY platform is built. External components reside in machines different location than the SYMPHONY main server and communicate using the SYMPONY RESTFul API.

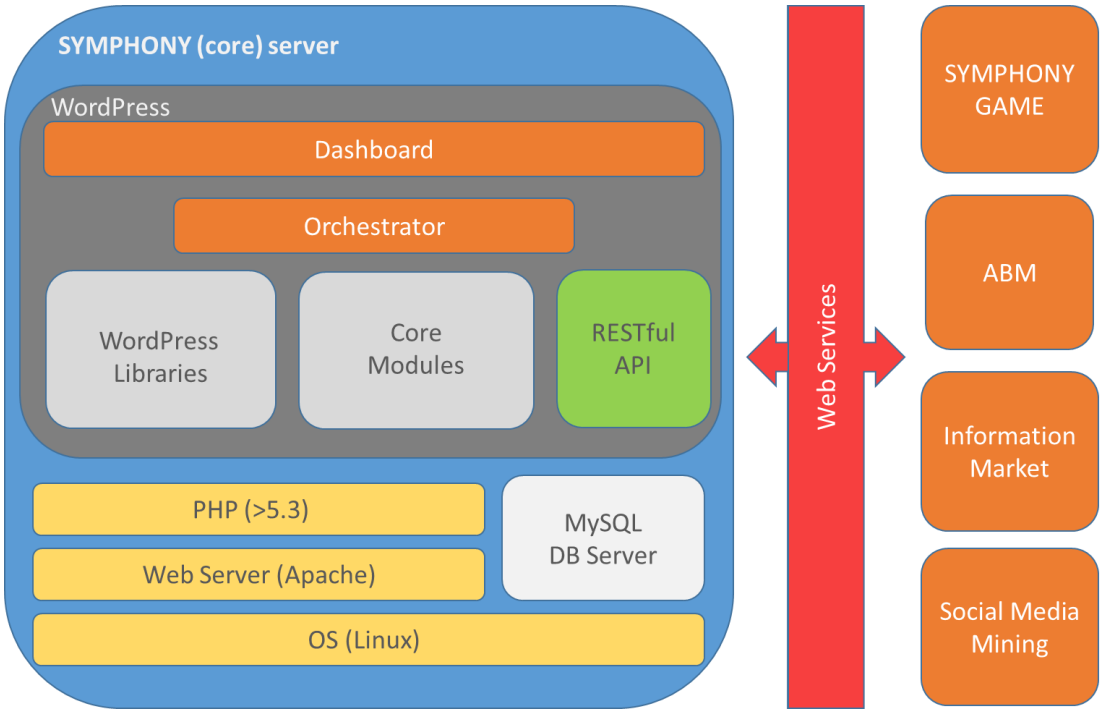

Figure 3-1: Physical Topology

A database server and a web server are also included in the platform. The web server is responsible for the SYMPHONY dashboard presentation and for the applications that run in the back-end of the dashboard. It is accessible through internet to all potential users, authenticated or not, depending on the services desired. It interacts with the database server in an appropriate way in order to handle, retrieve and display data to the end user.

Simultaneous data access, backup and auditing without any interruption of the web interface are ensured by the use of a database management system (RDBMS). The database server contains the actual content of the SYMPHONY front-end and the data needed by the rest of the components as well. It also contains the WordPress data structure which is the base for the platform's frontend elements as well as for the offered web services.

3.1 Deployment Diagram

The following UML deployment diagram provides information about the platform deployment topology.

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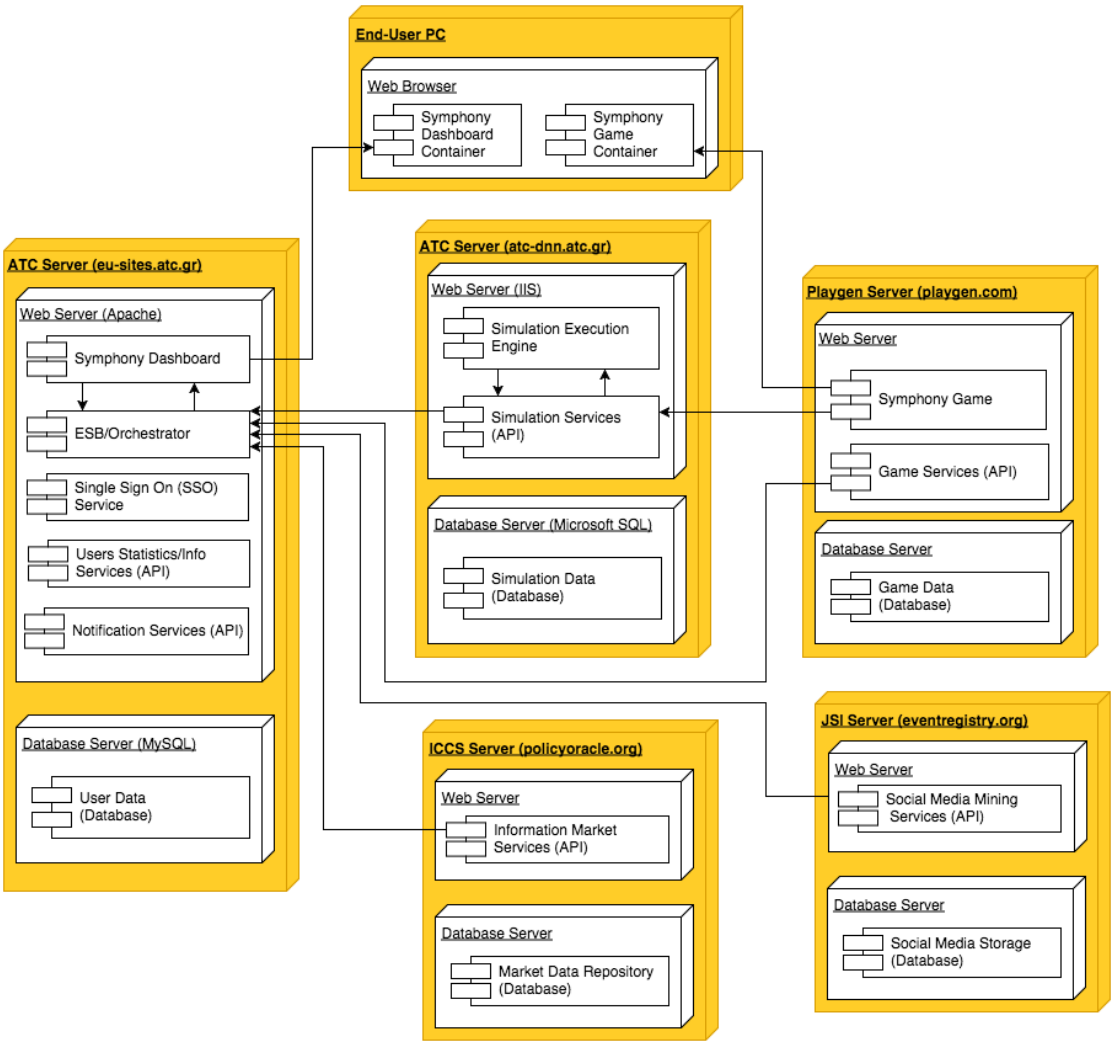

Figure 3-2: SYMPHONY's Deployment diagram

3.2 System Requirements & Infrastructure

The central SYMPHONY server machine has the following hardware requirements:

- CPU core > 2.0 GHz
- RAM > 4GB
- Disc Space > 30GB
- Internet connection with speed > 2Mbps

The software specifications required for the operation of the system includes:

- Ubuntu Server 14.04.1 LTS
- MySql 5.5.41
- Apache Web Server 2.7

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- PHP > 5.5 (with pdo, mysql, openssl, gd2 extensions enabled)

There are no specific client prerequisites to use SYMPHONY platform. The platform can be accessed by standard PCs, typical internet connections and web browsers. Nevertheless, a modern web browser (MS Internet Explorer (>v10), Mozilla Firefox, Google Chrome, Safari, Opera, etc.) is recommended and JavaScript must be enabled in order to use the platform.

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4 The SYMPHONY Testing Framework

4.1 The Software Assurance Process

The SYMPHONY platform has been technically evaluated and will be further evaluated in the context of WP6 activities in order to assess the maturity of the operational and technical implementation and the alignment to the user requirements from a technical perspective. The current assessment of the SYMPHONY platform is supported by monitoring the functional and technical parameters of the platform performance and aims to determine how far the platform meets the requirements.

From a technical perspective it is an internal self-assessment made by technical experts engaged in the project development phase. The experts are allocated a dedicated area of work in the form of small projects and, during the testing and technical assessment, they assess the impact of the projects they are involved in on the basis of their perception of success. SYMPHONY platform development is tested, according to established standards on software assurance process. This process aims to assess the efficiency of the platform functionalities and provides evidence that the platform is available for release through a software assurance process. In principle, software assurance can be realized by evaluating both the software itself (the product) and how it has been developed (the process). Both aspects are important to a platform targeting to support scalable functionalities, like the SYMPHONY platform. However, in research products such as the SYMPHONY platform, the software assurance of the process itself is almost impossible. It is mostly due to the constant change in both the design and the requirements of the software. In a research project, these changes occur during the project cycle itself, as a result of the ongoing research in the other work packages (reflected as changes in different components of the architecture) and since SYMPHONY platform development has been mainly based on agile software development. Thus, the software assurance process means testing the outcome of the research prototype, considering this as an integrated platform, consisting of the individual components, which can be reached via Web service implementation.

The SYMPHONY technical assessment practices will be based on the ISO/IEC 12207:2008 standard about software life cycle processes. From this standard, the software quality assurance process in clause 7.2.3 and the clause 7.2.5 about software validation process are adopted for the SYMPHONY platform. Software validation is the confirmation that the software specifications conform to user needs and intended uses through examination and provision of objective evidence, and that the particular requirements implemented through software can be consistently fulfilled. Since software is part of a hardware system, the software validation typically includes evidence that all software requirements have been implemented correctly and completely.

Software validation is realized through quality models. In the past, different quality models have been proposed, each of which addresses different quality attributes that allow evaluating the developed software. Some of the most well-known are:

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- McCall's model of software quality [9] (GE Model, 1977), which incorporates 11 criteria encompassing product operation, product revision, and product transition.
- Boehm's spiral model [10] (1978) based on a wider range of characteristics, which incorporates 19 criteria. The criteria in both, this and the GE model, are not independent as they interact with each other and often cause conflicts.
- ISO 9126-1 [11] incorporates six quality goals, each goal having a large number of attributes. These six goals are then further split into sub-characteristics, which represent measurable attributes (custom defined for each software product).

Recently the BS ISO/IEC 25010:2011 standard [12] about system and software quality models has replaced ISO 9126-1. Applying any of the above models is not a straightforward process. There are no automated means for testing software against each of the characteristics defined by each model. For each model, the final attributes must be matched against measurable metrics and thresholds for evaluating the results must be set. It is then possible to measure the results of the tests performed (either quantitative or qualitative/observed).

For the SYMPHONY case, we will adopted the ISO/IEC 25010:2011 standard, which is the most widespread reference model and it includes the common software quality characteristics that are supported by the other models. This standard defines two quality models providing a consistent terminology for specifying, measuring and evaluating system and software product quality:

- Quality in use model, which is composed of five characteristics that relate to the outcome of interaction with the system and characterises the impact that the product can have on the stakeholders.
- Product quality model, which is composed of eight characteristics that relate to static properties of software and dynamic properties of the computer system.

For our case, the product quality model is adopted. The eight characteristics, are further divided into sub-characteristics, are shown in

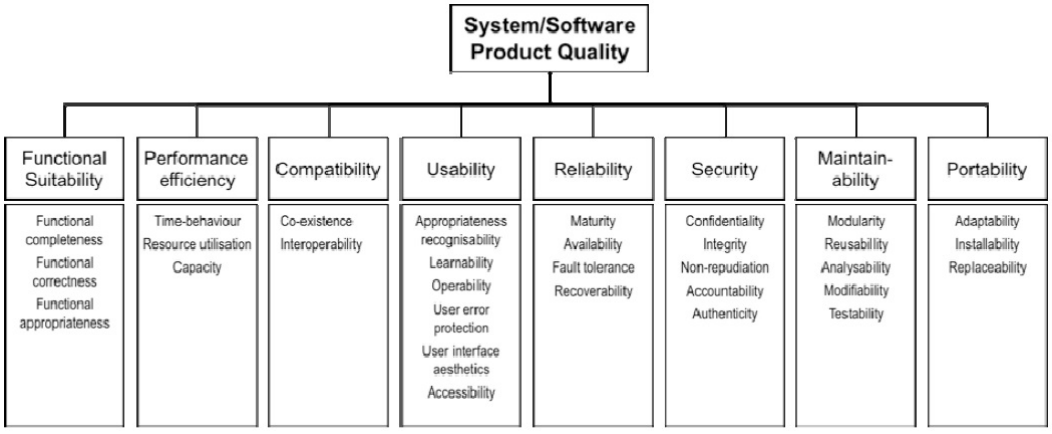

Figure 4-1 The ISO/IEC 25010:2011 system/software quality model characteristics

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For each of the sub-characteristics, a metric/measurable attribute is defined, along with thresholds. These metrics and thresholds are customized for each software product, which in our case is the SYMPHONY platform (consisting of individual components). By evaluating these metrics, we are able to assess the overall quality of our platform and the percent to which we were able to meet the user and technical requirements (reflected to system specifications and functionalities) defined during the design phase of the project. The metrics and the results of the technical and functional evaluation are identified and analyzed at the below sections.

4.2 The SYMPHONY Quality Model

The software quality model of the BS ISO/IEC 25010:2011 standard is adapted to the needs of the SYMPHONY platform, in order to define appropriate metrics and to be able to evaluate the platform capabilities. These metrics need to reflect the characteristics that they represent. They also need to allow appropriate measurements to be obtained, either through quantitative methods (e.g. by software tests/simulations, usability tests) or qualitative methods (e.g. through user observations). Three types of classes of metrics are defined in this standard:

- Internal metrics associated with static internal properties of a system such as number of function calls, number of rules.
- External metrics associated with dynamic external properties. These are metrics that are observable when the user interacts with the system (i.e. the user performs a task/function/operation and observes the response in the sense of time required, results obtained etc.).
- Quality-in-use metrics, which refer to metrics that evaluate the extent to which a system meets the needs of the user.

Since SYMPHONY is a research project and the aim of the relevant platform is that of a proof of concept and not a commercial product by the end of the project, there will be less focus on the internal metrics, which are essentially used in the development phase. As such, the different components and the platform itself will be mainly optimized for their functional suitability and usability. We will therefore concentrate on external metrics and quality in use metrics, which are respectively used in the testing phase and the piloting phase. Various target users should actually make use of these metrics, as follows:

- Developers and IT experts will make use of external metrics prior to the release of the SYMPHONY platform prototype to the evaluation phase
- Platform end users (i.e. policy makers, domain experts, policy consultants, journalists, etc.) will make use of quality-in-use metrics, during evaluation to assess the suitability of the prototype to address the needs in the policy formulation domain.

It must be clarified that in the scope of WP5, only the external metrics will be reported, through the planned period for testing the SYMPHONY prototype prior to the release to other WPs. The quality-in-use metrics are attributed to the work in WP6 and will be closely

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related to the defined user scenarios for instantiating SYMPHONY in real policy formulation paradigms.

Due to the nature of the SYMPHONY platform, we concentrate on the following BS ISO/IEC 25010:2011 characteristics for the SYMPHONY platform, as shown below in Table 10.

ISO/IEC 25010:2011 characteristics	Description	Method for measuring quality metric	Threshold[7]
Functional Suitability			
Functional Completeness	Assess the implemented functionalities with respect to requirements and project objectives	Observation Tests	# of implemented functionalities > 95%
Functional Appropriateness	Assess whether the implemented functionalities facilitate the accomplishment of specified tasks and objectives	Log Analysis, Observation Tests	# of correct actions > 95%
Performance Efficiency			
Time Behavior	Assess the response and processing times and throughput rate per user	Log Analysis, Observation Tests, Simulation Tests	Mean Response Time < 1 min Mean Throughput < 2Mbps
Resource Utilization	Assess the resource usage	Log Analysis, Simulation Tests	Memory and CPU usage < 50%
Capacity	Assess the number of concurrent users	Simulation Tests	# of con_users > 10
Compatibility			
Interoperability	Assess the interoperability	Observation Tests	Interoperability with at least two other

[7] For the given configuration of the SYMPHONY core Server and at least for the SYMPHONY official evaluation periods

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ISO/IEC 25010:2011 characteristics	Description	Method for measuring quality metric	Threshold[7]
	capabilities of the SYMPHONY prototype		separate systems

Table 10: Definition of evaluation metrics and success criteria

4.3 Definition of test cases and test results

4.3.1 Functional Suitability

In order to test the functional suitability of the implemented functionalities, the SYMPHONY platform has been used by developers and IT experts to identify the prototype behavior with respect the planned one and to check whether the user requirements, as they are presented in the SYMPHONY Deliverable D2.1 [2], and the functional requirements, as they are presented in the SYMPHONY Deliverable D5.1 [7], have been addressed.

The testing process follows a number of test use cases, which are iteratively repeated. These tests should be successfully accomplished from the SYMPHONY platform and in all iterations they should provide the same results. The test cases relate to the SYMPHONY requirements and for each of them the result of the testing process is reported. For all the test cases, the http client of the SYMPHONY platform prototype has been used as the method for observation testing, while direct access to the logs of the SYMPHONY Server ensure that the intended use of the functionalities is performed (with no programming level exceptions to be occurred).

4.3.1.1 Functional Completeness

The functional completeness of the SYMPHONY platform refers to satisfying the user and functional requirements as introduced in the first year of the project. Currently, the development of the SYMPHONY platform partially meets the use cases, as depicted in D5.1 and listed at the below table. The estimated degree of fulfilment is justifiable from the fact that the project targeted to the delivery of core functionalities at this phase.

UC CODE	USE CASES	ACTORS	Estimated Degree of fulfilment
UC1	Create account – register to platform	Policy Maker / Policy Advisor, Citizens / Industry / Civic society	100%
UC2	Login	Policy Maker / Policy Advisor, Citizens / Industry / Civic society	100%
UC3	Participate in the Information Market	Citizens / Industry / Civic society	70%
UC4	Participate in the Game	Citizens / Industry / Civic society	60%
UC5	Citizens Expectations from SM	Policy Maker / Policy Advisor	70%
UC6	View sentiment analysis of public opinions for a domain	Policy Maker / Policy Advisor	50%
UC7	View experts expectations on specific events	Policy Maker / Policy Advisor	60%

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UC CODE	USE CASES	ACTORS	Estimated Degree of fulfilment
UC8	Get a graphical view of Citizens' expectations	Policy Maker / Policy Advisor	60%
UC9	Acquire an estimation of event evolution in the future	Policy Maker / Policy Advisor	60%
UC10	Acquire an estimation of how social media signals align with macroeconomic trends	Policy Maker / Policy Advisor	70%
UC11	Acquire an estimation of the impact of the different economy scenarios	Policy Maker / Policy Advisor	60%
UC12	Manage roles	Administrator	70%
UC13	Manage users	Administrator	80%
UC14	Monitor system	Administrator	60%

4.3.1.2 Functional Appropriateness

The functional appropriateness has been tested through iterative test cases performed in 20 cycles and for a period of time of one week. The below table shows the results of this test process for selected functionalities offered so far from the SYMPHONY platform. For each test case, the relevant SYMPHONY platform use case is indicated, so that a connection of the test cases with the defined tasks and objectives and the current status of the platform is realized.

Test Case	Relevant Use Case	Result
User Registration, user login to the SYMPHONY platform and view dashboard according to his/her role	UC1, UC2	Success
View available markets and contracts of a market	UC3, UC7	Success
Buy/Sell shares and create/edit a market	UC11	Success
View list of markets created by a user	UC11	Success
View graph with total amounts spent by the user	UC3, UC7, UC11	Success
View list of transactions and a transaction info	UC3, UC7, UC11	Success
View information about user's balance history and user's points.	UC3, UC7, UC11	Success
Define a trend and find correlated trends	UC5, UC6, UC7, UC9	Success
View changes happened on game agents' variables	UC4, UC8, UC11	Success
View game leaderboard	UC4, UC8, UC11	Success

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Test Case	Relevant Use Case	Result
View statistic data about the running games	UC4, UC8, UC11	Success
View Game list	UC4, UC8, UC11	Success
Create a new game	UC11	Success
View statistic data about the dashboard's registered users	UC12, UC13, UC14	Success

Table 11: The functional appropriateness of the SYMPHONY platform

4.3.2 Performance Efficiency

In order to test the performance of the services used in the SYMPHONY Initial platform prototype, the popular open source tool JMeter was used. JMeter[8] is designed to load test functional behavior and measure performance of web applications and web services. Web Services Test Plans were created to test the performance of the services that offer the desired functionality to SYMPHONY. These services support the communication of SYMPHONY components with the orchestrator's web service (RESTful APi).

The conducted tests include the creation of indicative scenarios with 5/10/20 concurrent users that send http requests (service calls) to the server and run this test 4 times.

In order to derive these numbers of concurrent users, the following assumptions were made:

- 90.000 visitors/month or 3000 visitors/day to the SYMPHONY platform were assumed, a number significant large considering the purposes of the SYMPHONY tools
- The average time the user spends on each SYMPHONY page is 5 minutes or 300 seconds
- The number of concurrent users consuming the same service at the same second is derived by the formula: Number of Concurrent users = Rate of incoming visitors * time of visit (where Rate of incoming visitors is the number of visitors per second)

By using the numbers mentioned above the Rate of incoming visitors is 0,0347 visitors per second and the concurrent users is 10,41.

The following tables present the performance results of the Web Test for the different number of users. The first column shows the services that were tested and the rest of the columns represent the various metrics measured by JMeter. More specifically, through JMeter the following results are retrieved:

Information Market Services (IM)

[8] http://jmeter.apache.org/

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Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**
List of open markets	GET	0.453	0.793	1.402
List of contracts in a market	GET	0.151	0.181	0.362
New market	POST	0.559	0.571	0.638
Edit market	POST	0.174	0.221	0.369
New transaction	POST	0.500	0.758	1.084
User balance history	GET	0.152	0.259	0.417
User trade history	GET	0.411	0.613	0.628
User current holdings	GET	0.172	0.331	0.517
User markets	GET	0.244	0.529	0.844
User points	GET	0.146	0.288	0.445
User shares	GET	0.200	0.272	0.556

Social Media Mining Services (SMM)

Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**
List of suggested concepts	POST	0.100	0.105	0.120
List of suggested categories	POST	0.080	0.114	0.115
Test data relevant for a concept	POST	25.907	39.554	79.733
Concepts relevant for a domain	POST	27.981	47.069	79.980
Compute top correlations	POST	1.193	3.394	6.153
Compute regression model	POST	13.179	11.897	29.395

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Users Statistics/Info Services (Dashboard)

Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**
Users statistics	POST	0.274	0.340	0.529
User info	POST	0.173	0.291	0.506
List of registered users	POST	0.192	0.329	0.527

Simulation Services (ABM)

Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**
Game's info	GET	0.009	0.012	0.013
List of running games	GET	0.024	0.058	0.085

Notification Services (Orchestrator)

Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**
Sent notifications	POST	0.175	0.289	0.531
All received notifications	POST	0.174	0.349	0.528
New received notifications	POST	0.168	0.313	0.661
Notification clicked event	POST	0.182	0.271	0.496
Notifications seen event	POST	0.262	0.473	0.509

Game Services (GE)

Service		Response Time (seconds)		
Name	**Method**	**5 Users**	**10 Users**	**20 Users**

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Game statistics	GET	0.564	0.654	1.154
Game activity	GET	0.140	0.736	1.142
Stocks	GET	0.597	0.614	1.397
Leaderboard	GET	0.223	0.274	0.494

4.3.3 Compatibility - Interoperability

The SYMPHONY platform is designed and developed under the principle of a loosely coupled architecture, taking into consideration international standards on the data transformation and information exchange, as well as the potential interoperability with third party systems. The individual components communicate with each other through well-defined APIs over REST Web Services, while JSON/XML data exchange schema has been adopted.

On the presentation layer, all components are delivered as a service and are currently integrated into the SYMPHONY dashboard as portlets, which makes them being independent from the specific technology used for the presentation layer.

5 SYMPHONY User Interface

In order to implement the User Interface (UI) of the SYMPHONY initial platform prototype that follows user and technical requirements, we decided to start by designing mockups of the dashboard that presents the wireframe of SYMPHONY's UI. The following mockups Figure 5-1 & Figure 5-2 have been developed with the Balsamiq Mockups[9] and presented to the consortium in order to be discussed in details concerning the platform's pages, user roles page sections and related functionality.

[9] https://balsamiq.com/products/mockups/

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Figure 5-1: Indicative SYMPHONY mockups for the Simple User

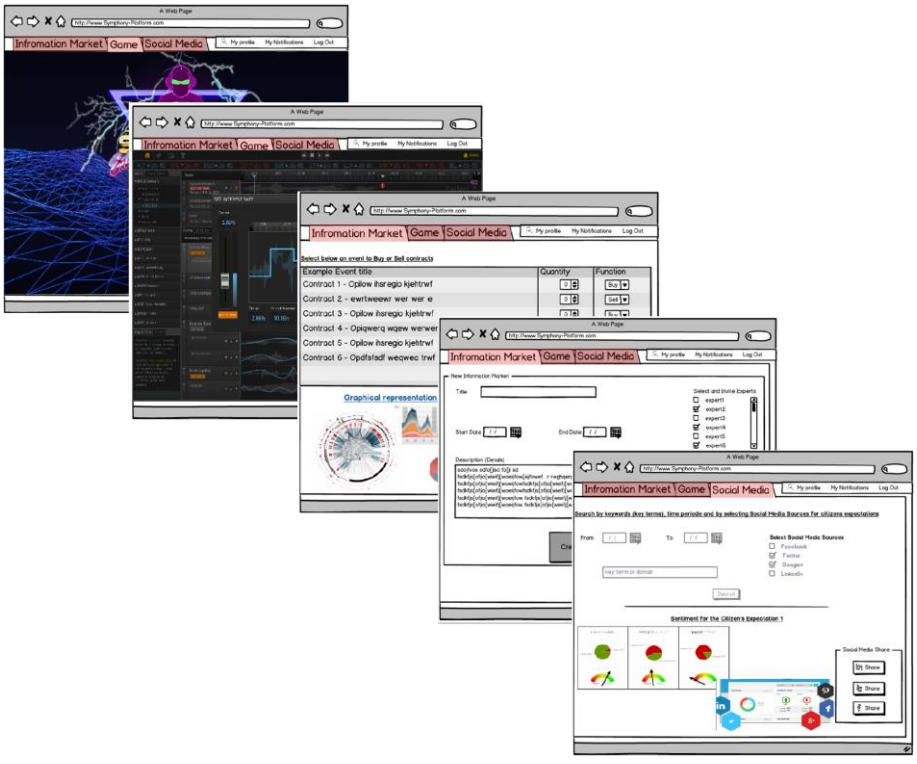

Figure 5-2: Indicative SYMPHONY mockups for the Advance User

The outcome of Consortium's discussions regarding SYMPHONY's UI is a set of professional web pages which stands as the current User Interface of the initial platform dashboard. Indicative screenshots of Simple and Advance User dashboard are presented below as is described in more details at Section 6 of this document.

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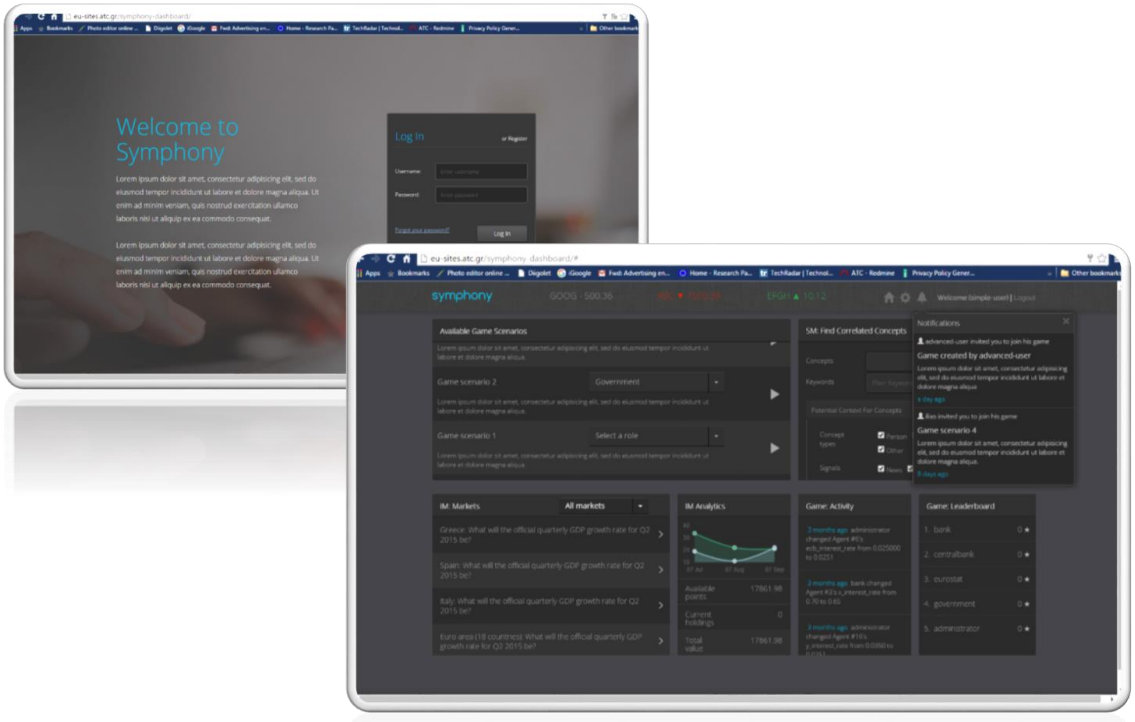

Figure 5-3: Indicative SYMPHONY screenshots for the Simple User

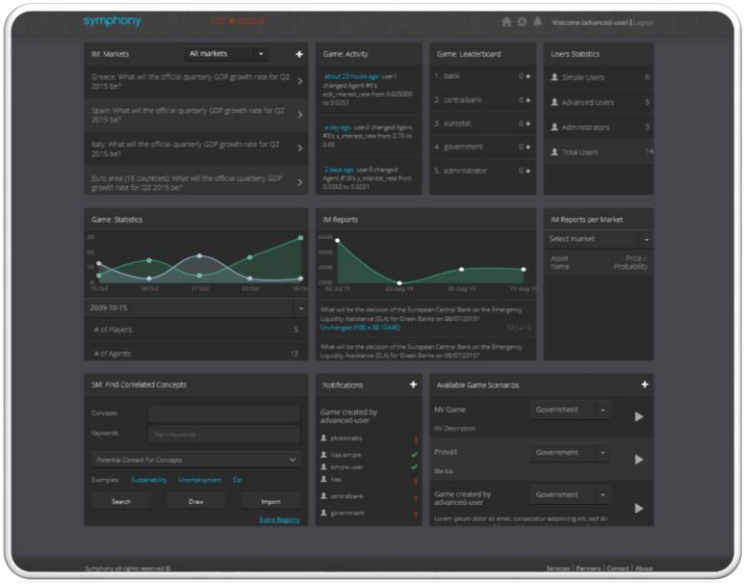

Figure 5-4: Indicative SYMPHONY screenshots of Advance User's dashboard

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6 Platform User Guide

6.1 SYMPHONY Dashboard

The following paragraphs present SYMPHONY's dashboard User Guide of the initial platform prototype, which is accessible by the following URL.

URL: http://dashboard.projectsymphony.eu

The dashboard consists of widgets which run independently where Users have to 'Log In' in order to have access to the symphony dashboard. The dashboard's user interface is dynamic and it is adjusted depending on the user's system role (administrators, advanced users, simple users) which are presented at the following section.

6.1.1 System Roles

As mentioned above, there are three types of system roles, which have different privileges. By default after sign-up each user is a simple-user, and the only user that can change the role of a user is the administrator.

6.1.1.1 Simple User

Simple user has access to a subset of the dashboard's widgets and content which cannot be altered by the simple user role.

6.1.1.2 Advanced User

Advanced user has access to all the widgets and can alter the dashboard's information, by adding new data or updating existing one.

6.1.1.3 Administrator

Administrator has the privileges of the advanced user as well as additional privileges. Some of the additional privileges are:

- Create new user/ Delete existing user
- Change a user's role

6.1.2 User Interface

In this section we present the interaction of users with the Symphony Dashboard.

6.1.2.1 Main Windows and Navigation

The Symphony Dashboard consists of three main windows:

- Register Window
- Log In Window
- Dashboard Window

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The diagram below (Figure 6-1) presents how end users can navigate among the main windows.

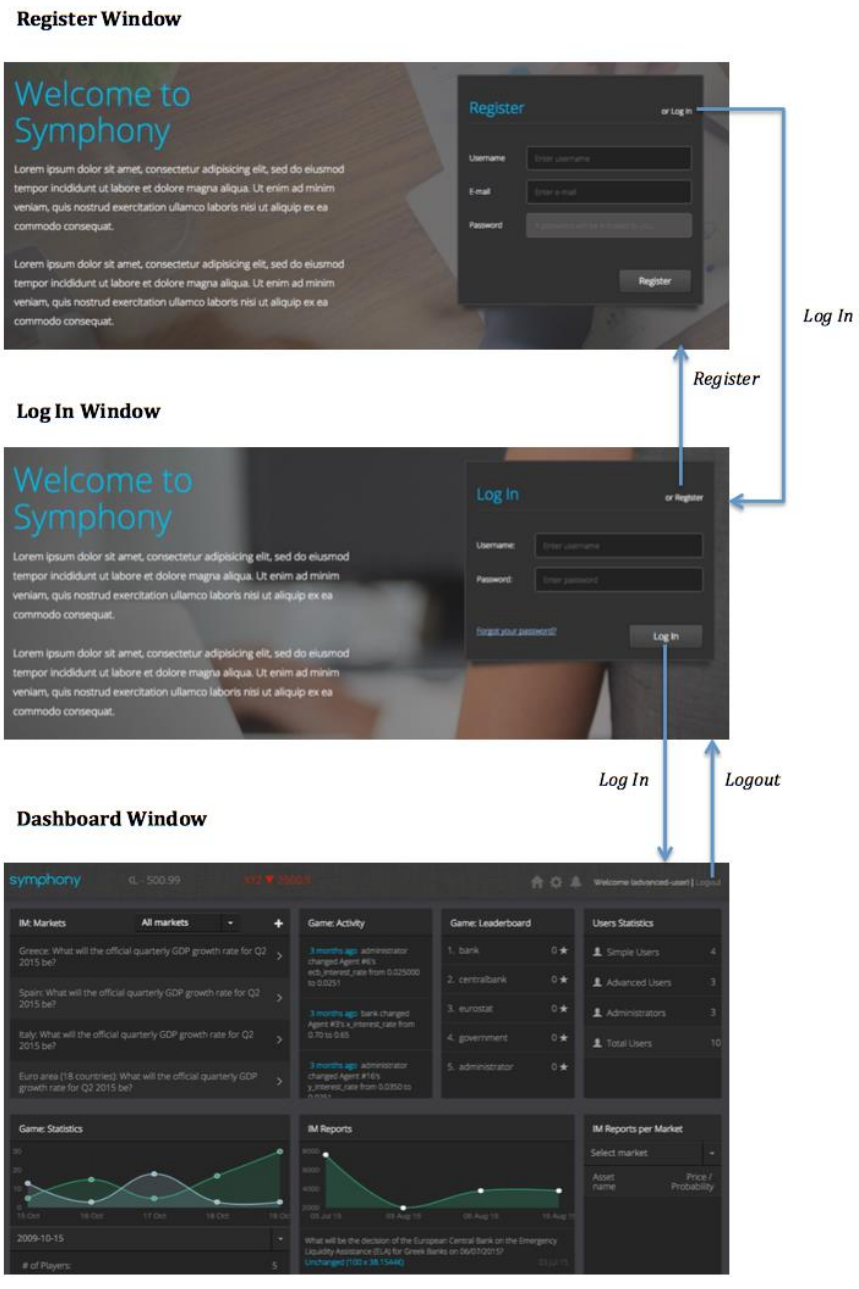

Figure 6-1: Main windows and navigation

6.1.2.2 Register Window

This window contains a register form (Figure 6-2) that allows the end user to register to the system. More specifically, the end-user has to fill in the form fields, which are:

- Username
- E-mail (unique email)

In contrast with the other fields (username, email), password is set by the system and is sent to the end-user's email. In this way, the system verifies the user's email.

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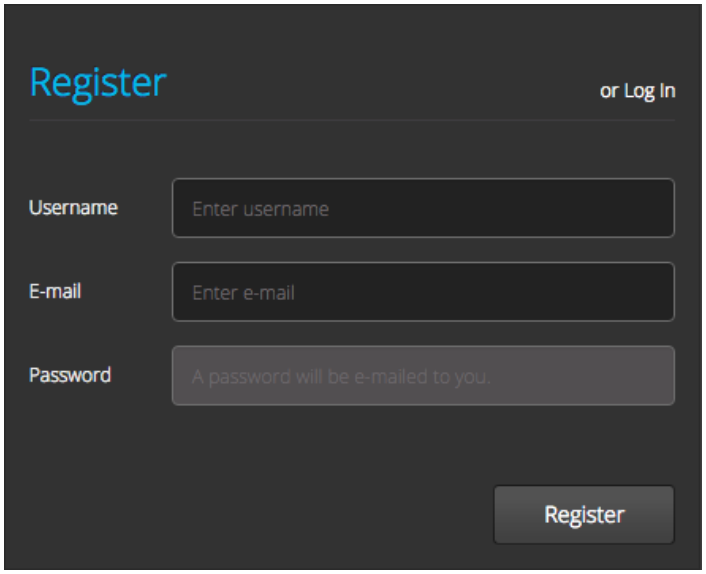

Figure 6-2: Register form

6.1.2.3 Log In Window

Log In window contains a form (Figure 6-3) that allows the end user to log in to the system. More specifically, the end-user has to fill in the form fields (in order to log in to the system), which are Username, Password.

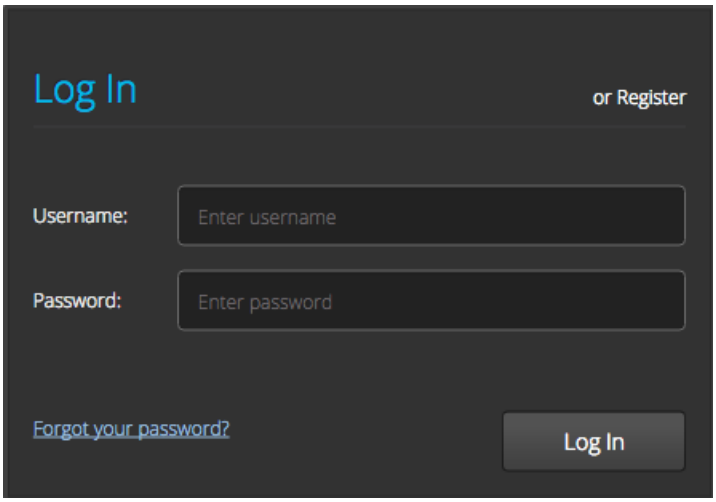

Figure 6-3: Login form

6.1.2.4 Dashboard Window

The dashboard window (Figure 6-4) is one of the main windows and consists of a header navigator (Figure 6-6) and a set of widgets, which implement the functionalities of symphony.

As mentioned in the introduction, the dashboard's user interface is dynamic and it is adjusted depending on the user's system role where dashboard provides extra functionality

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to the advance user than of simple's related to IM, SMM and game. So, depending on the user's role there exist two different views of the dashboard window. (See Figure 6-4 and Figure 6-5)

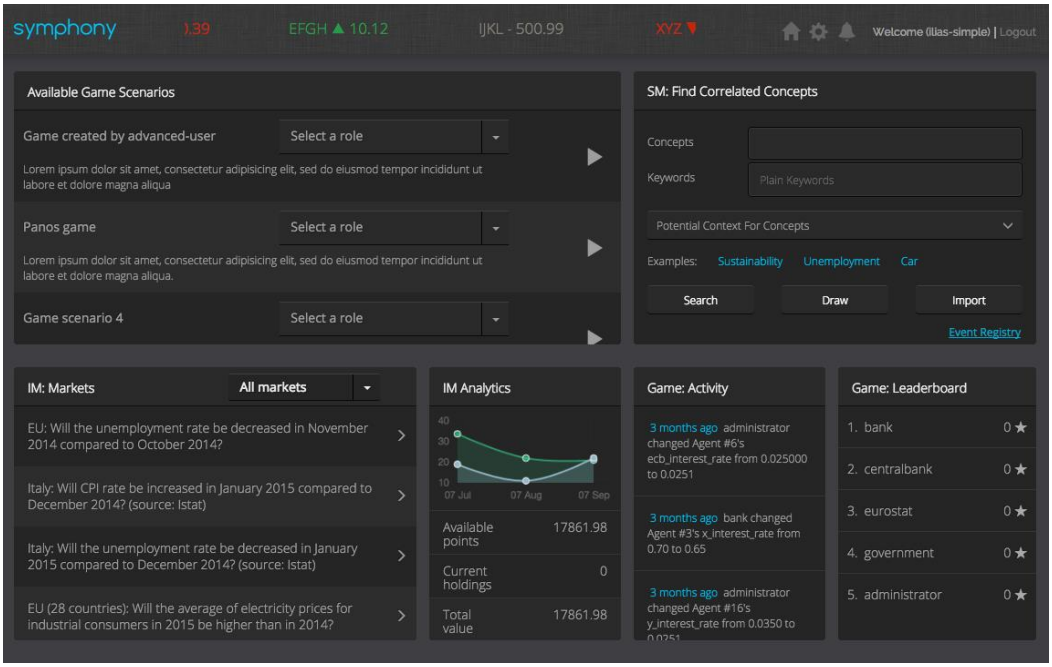

Figure 6-4: Dashboard window as shown in the simple-user

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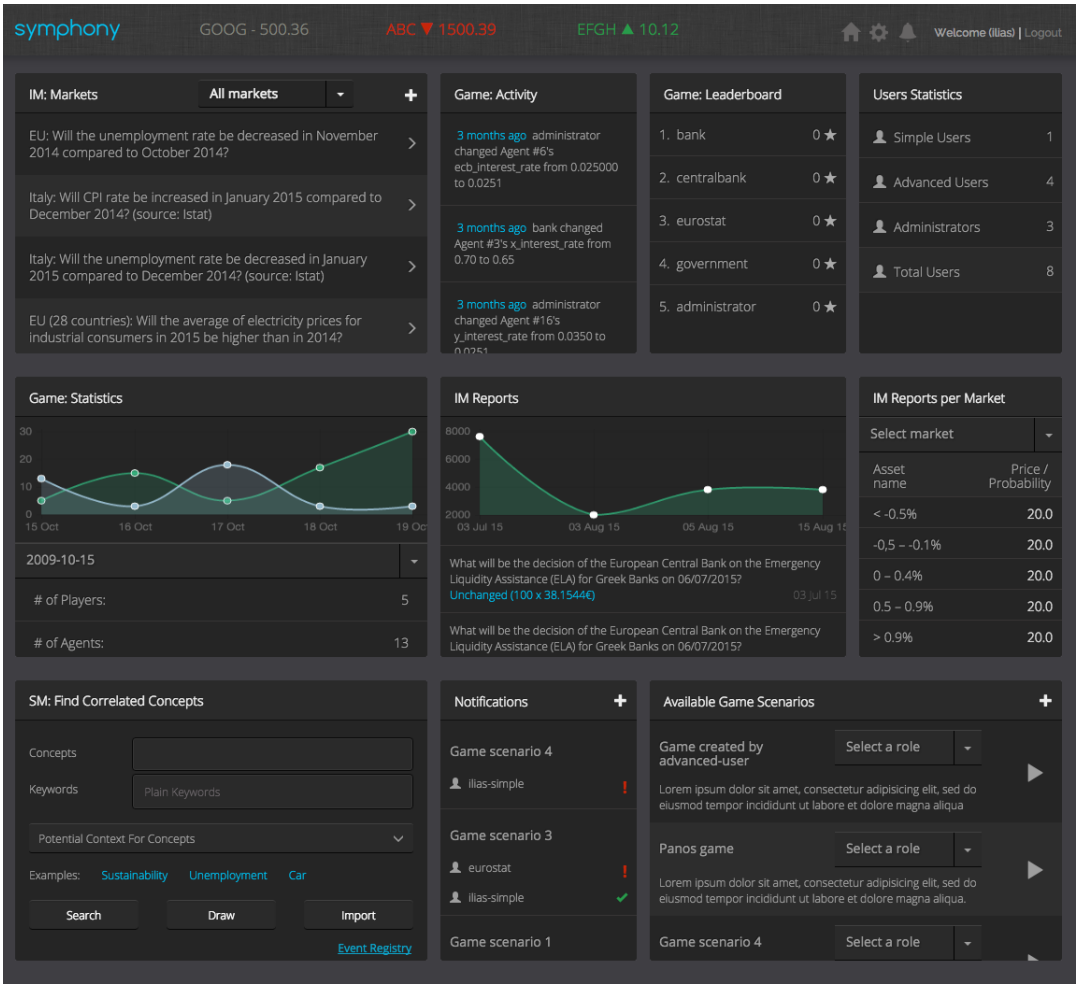

Figure 6-5: Dashboard window as shown in the advanced-user

Header

The header consists of the symphony's logo, a stock-ticker and user-tools.

Figure 6-6: Header

Stock Ticker

Information regarding the SYMPHONY's game virtual Stocks (Figure 6-7) are displayed with three different colors:

- Green, which means that the stock is rising
- Red, which means that the stock is falling
- Grey, which means that the stock is neither rising or falling

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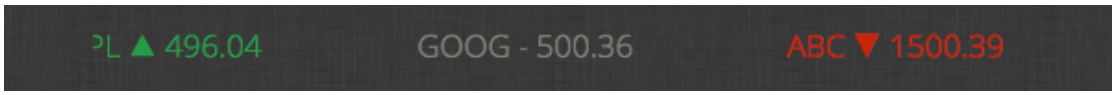

Figure 6-7: Stock ticker

User Tools

User tools (Figure 6-8) consist of:

- Set of Icons
    - Home *Icon*

      When user clicks this icon, he is redirected to dashboard window

    - Options Icon

      When user clicks this icon, he is redirected to options window so he can change personal information and other options (It's not available yet in the 1st version of the Symphony Dashboard)

    - Notifications Icon

      When user clicks this icon, a popup window (which contains a list of received notifications) is displayed

- Welcome Message

  This message welcomes the logged in user by displaying his username.

- Logout Option

  By clicking the logout link the user is logged out from the system and he is redirected to log in window.

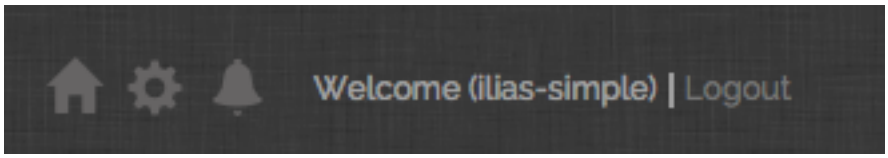

Figure 6-8: User tools

Notifications Popup

As mentioned above, the notifications popup (Figure 6-9) is displayed after user clicks on notifications icon. The notifications popup contains a list of notifications sent by advanced-users, which have created games and invite the logged in user to join their games.

The first line of each notification shows users' role and who invited the end user to a SYMPHONY game. After this follows the game's name (with bold letters) and game's description (paragraph). With the blue color it's shown the time were the notification was sent.

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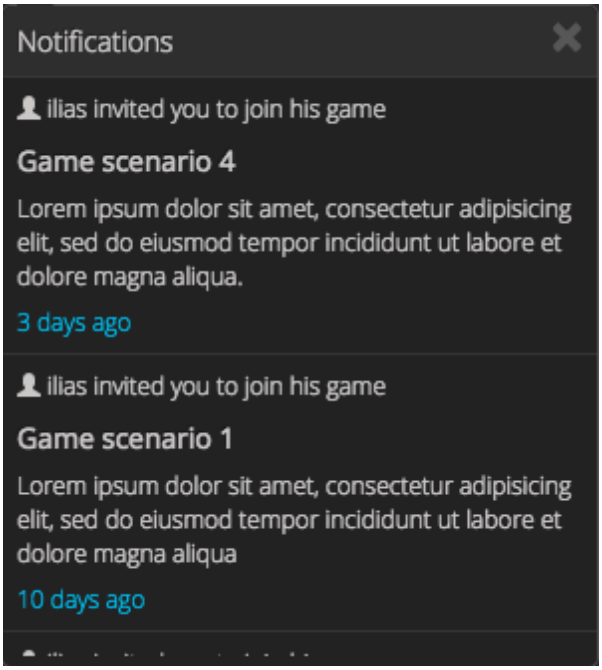

Figure 6-9: Notifications popup

IM Widget

IM Widget gives end user the ability to:

- View available markets

It is the default window of the IM Widget that shows a list of available markets' names (Figure 6-10). In the header of the widget there is a drop down menu that gives users the ability to filter markets by category. More specifically, the 'My markets' option shows a list of markets created by the logged in user. Here it is worth mentioning that only advanced users (and administrators of course) can create a new market. Therefore, the plus icon (that means the creation of new market) is displayed only on advanced users. By clicking on a market's name, the end user is redirected to contracts window. (Figure 6-11)

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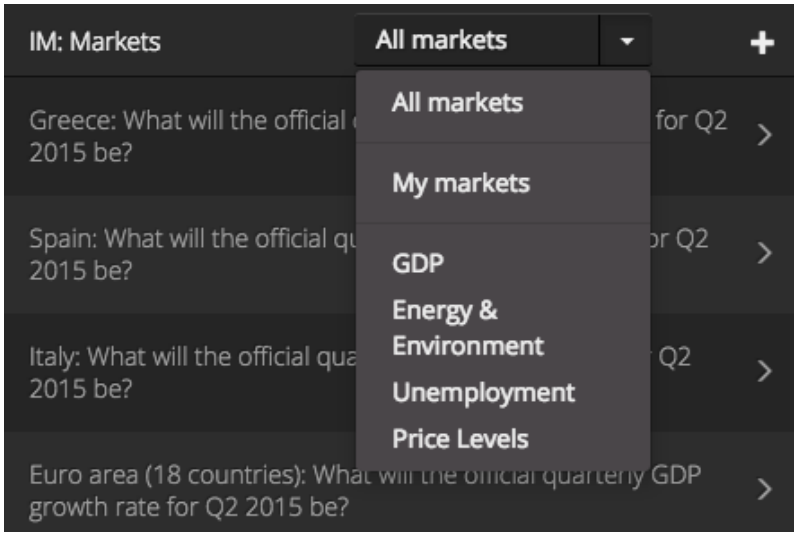

Figure 6-10: IM Widget - List of markets

- View contracts of a market

This window (Figure 6-11) shows the available contracts of the previously clicked market and their prices/probabilities. By clicking on a contract, end user is redirected to buy/sell shares window. (Figure 6-12)

Figure 6-11: IM Widget - Contracts in a market

- Buy/Sell shares

The buy/sell shares window (Figure 6-12) gives to the user the ability to buy or sell shares of the previously clicked contract. The user defines the number of shares that he wants to buy or sell and then presses the 'Confirm' button in order to complete the transaction. Otherwise he could press the 'Not sure yet' button and return back to contracts window.

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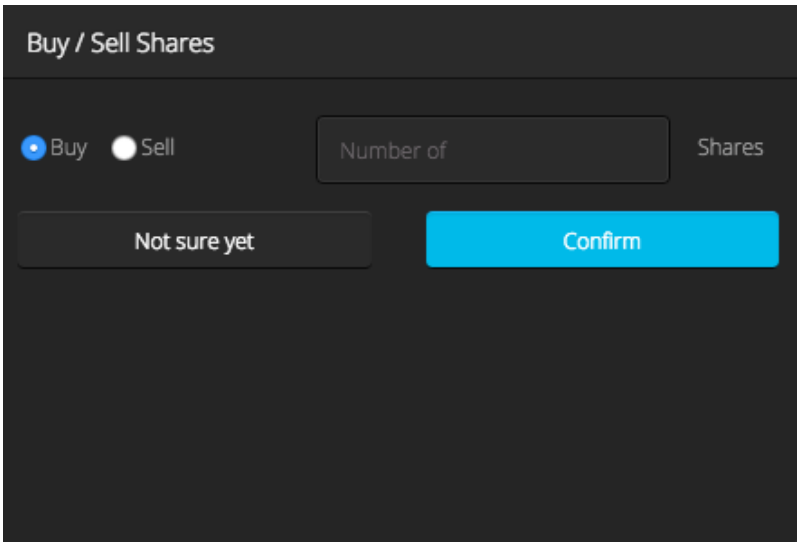

Figure 6-12: IM Widget - Buy/Sell shares of a contract

- Edit market

This window (Figure 6-13) is displayed when user clicks on edit icon (up-right) from the contracts window (Figure 6-11). Through this window user can edit:

  - Market's name
  - Market's description
  - Market's category

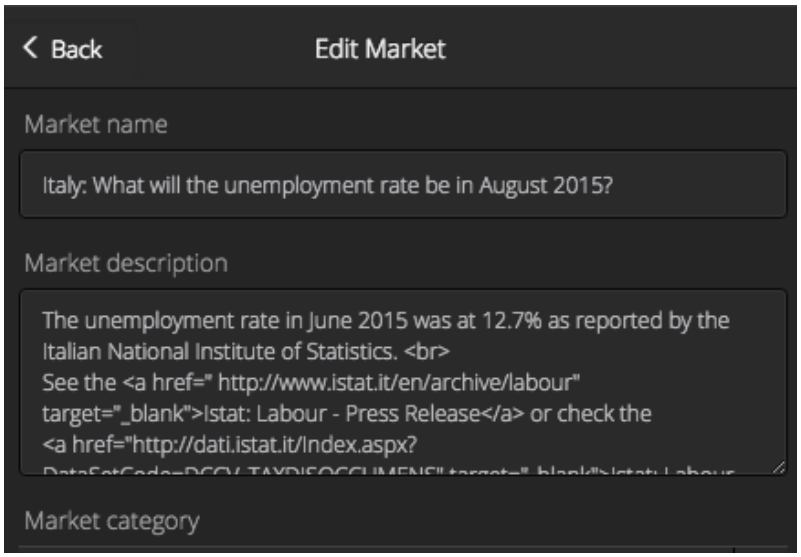

Figure 6-13: IM Widget - Edit a market

- Create new market

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This window (Figure 6-14) is displayed when the user clicks on plus icon (up-right) from the markets window (Figure 6-10). Through this window user can add a new market, by filling in the fields:

- Market's name
- Market's description
- Market's category
- Market's type
- List of the new market contracts

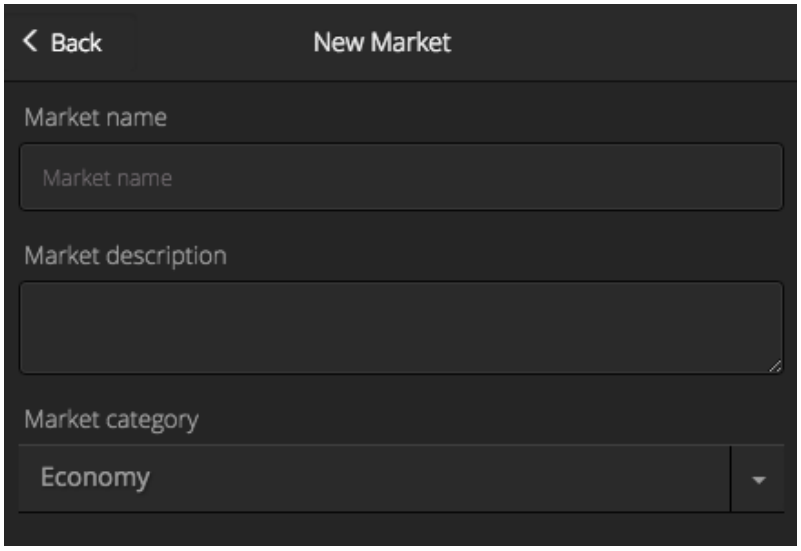

Figure 6-14: IM Widget - Create a new market

IM Reports Widget

The IM Reports Widget (Figure 6-15) shows two main things:

- Graph with total amounts spent by the user

This graph shows the total amounts spent by a user during a time period. By saying total amount, we mean the amount a user spent by buying shares of contracts (from diverse markets) during a day. So, the Y-axis shows the amount and the X-axis shows the date.

- List of transactions

This list shows all the transactions (buy/sell shares) completed by the user in the past. Each list item shows information about a completed transaction:

- Market's name

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This is the market from which the user bought the shares.

- Transaction's Info

E.g. Unchanged (100 x 38.1544 €): This means that the user bought 100 shares of the contract 'Unchanged' and spent the amount of 38.1544 € in order to buy those shares.

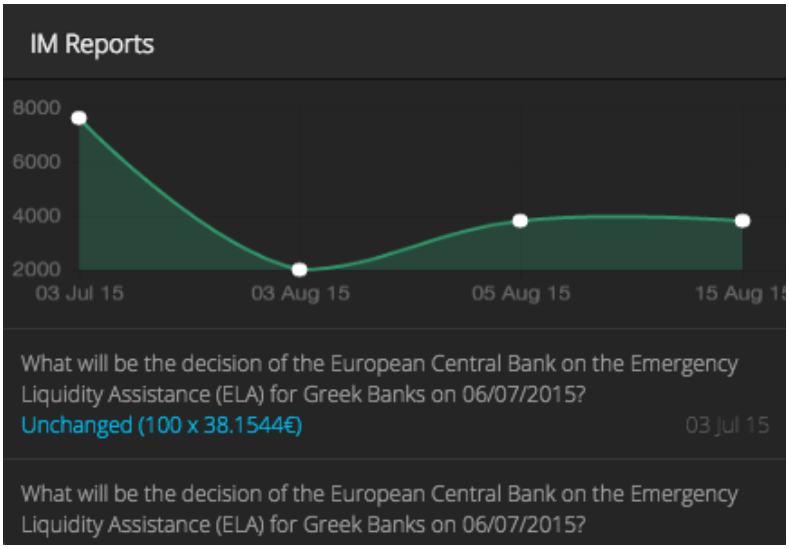

Figure 6-15: IM Reports Widget

IM Reports per Market Widget

This widget displays the list of markets created by the end user (Figure 6-16). Then the user selects a market from the dropdown list, in order to see the contracts of the selected market (Figure 6-17). This widget is displayed only in advanced users' dashboard, since only advanced-users could create new markets.

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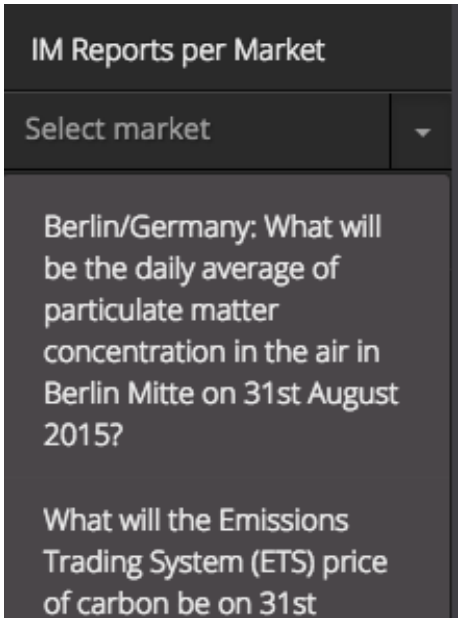

Figure 6-16: IM Reports per Market Widget - List of markets

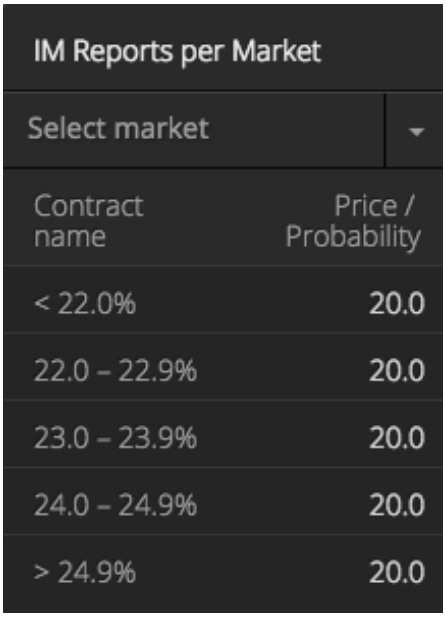

Figure 6-17: IM Reports per Market Widget - Contracts of market

IM Analytics Widget

The IM Analytics Widget (Figure 6-18) gives information about user's balance history and user's points. As seen it consists of two areas:

- Graph

  The graph shows the balance history of the user (corresponding total profits/ losses from transactions (buy/sell) completed by user)

- List

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The list shows the points of the user, which are:

- Available points: Cash available for trading (buy/sell shares)
- Current holdings: Value of user's investments (shares)
- Total value: Sum of cash and investments

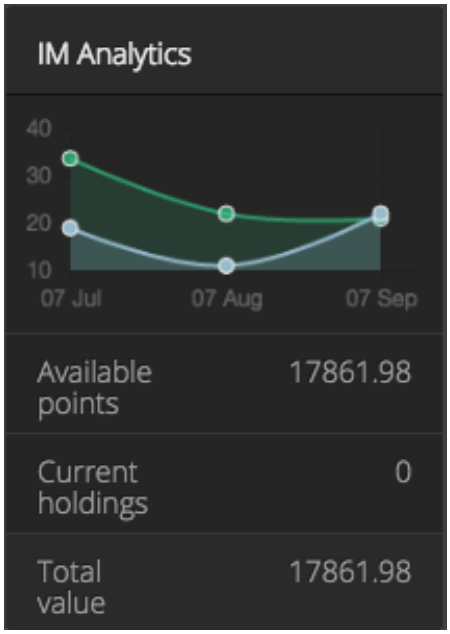

Figure 6-18: IM Analytics Widget

SM Correlated Concepts Widget

The SM Correlated Concepts Widget lets user to define a trend and then find correlated trends, based on social media mining. User can define a trend using one of the following methods:

Specify search conditions

As seen at Figure 6-19 users can define a trend by entering a concept name (or multiple concept names) in the concepts input or entering some plain keywords in the keywords input. We should mention that users can enter concepts or keywords, as well as both of them. Concepts input is an autocomplete input, which means that when the user types some characters he gets suggested concept names. (Figure 6-20)

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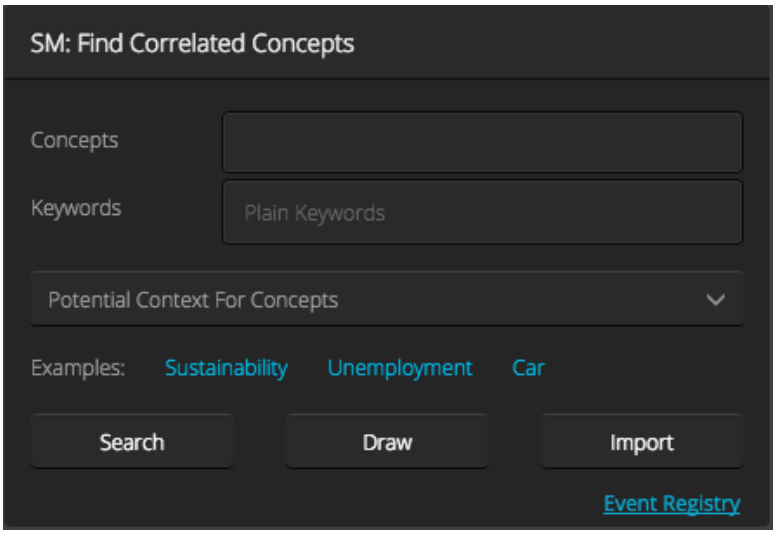

Figure 6-19: SM Correlated Concepts Widget - Search form

For example when a user wants to find trends correlated with Barack Obama. Firstly user begins typing the first letters 'Bar' and he gets available suggested concepts (Figure 6-20).

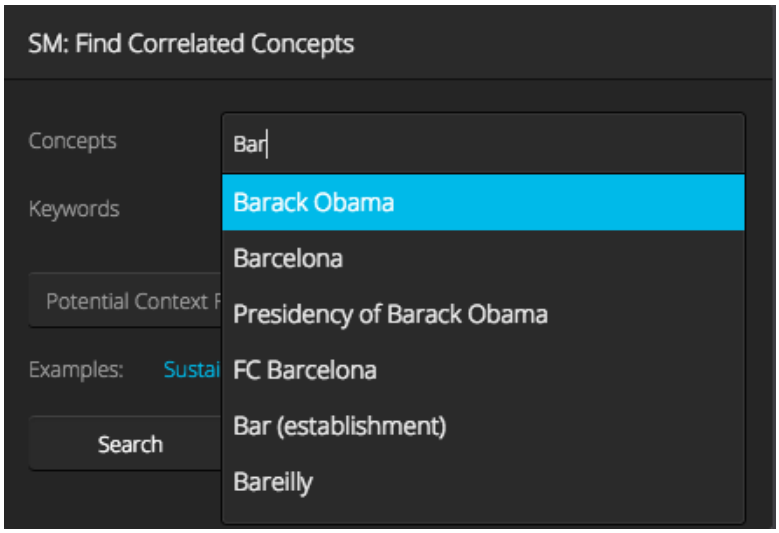

Figure 6-20: SM Correlated Concepts Widget - Suggested concepts

Then user selects his desired concept name 'Barack Obama' and the concept is inserted in the concepts input (Figure 6-21). The user could also select multiple concept names and optionally could enter plain keywords.

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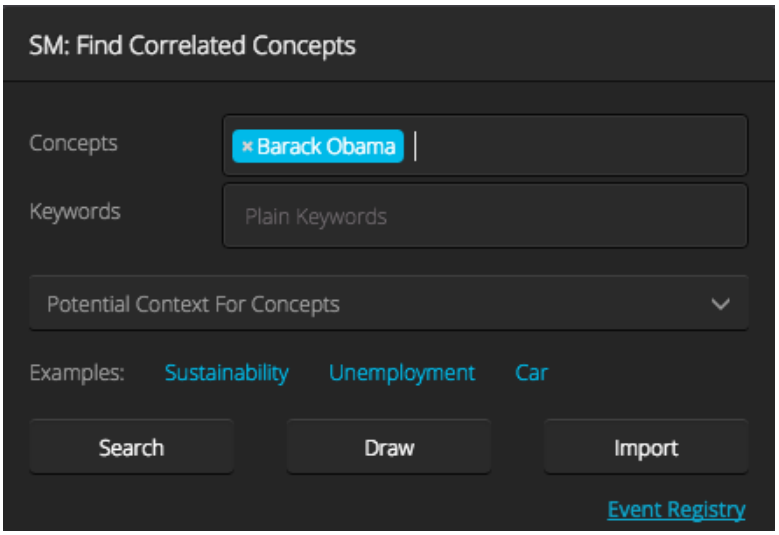

Figure 6-21: SM Correlated Concepts Widget - User selected suggested concept

Before starting the search of correlated trends user could (optionally) define the context by clicking on the collapsible menu 'Potential Context For Concepts'. Once user clicks that, the collapsible area is expanded (Figure 6-22) and gives user the option to define:

- Concept types: *Determines what types of concepts should be considered in computation of top correlations*
- Signals: *Determines the sources of concepts' articles*
- Category: *Determines the category and it's an autocomplete input*

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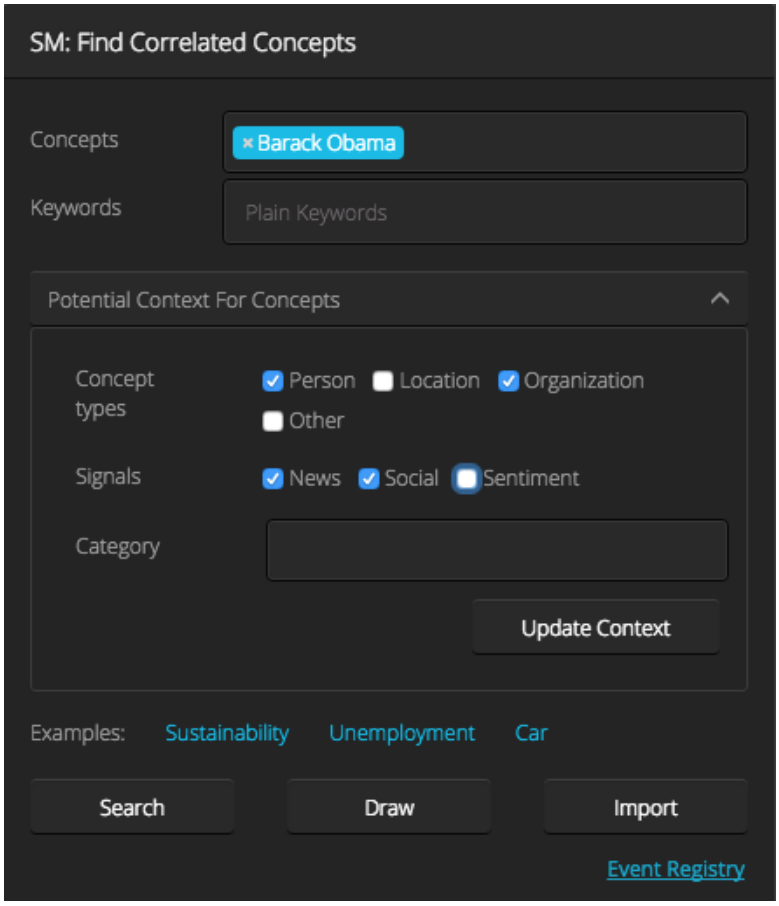

Figure 6-22: SM Correlated Concepts - Potential Context collapsible menu

When definition of trend has completed, the user clicks on 'Search' button in order to search for correlated trends. Once the search has finished, top correlated trends are presented to the user in the form of:

- Graph

  In the graph (Figure 6-23) are presented the top three correlated concepts. The Y-axis presents the number of articles that mention each correlated concept, and the X-axis presents the date. User could remove one concept's graph by clicking on the concept's name. Also, the user can zoom-in, zoom-out and can scroll the graph left or right.

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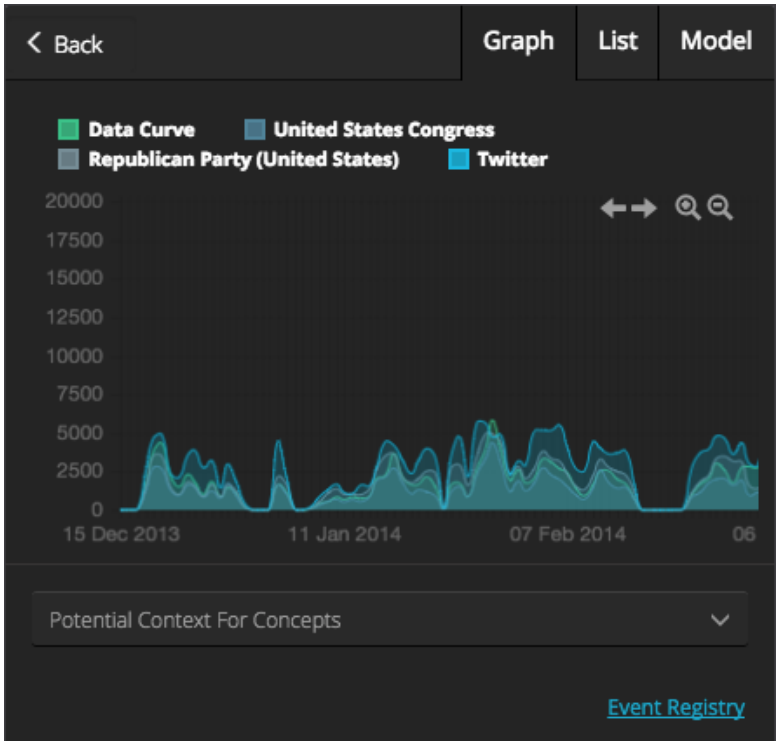

Figure 6-23: SM Correlated Concepts - Graph of top correlated trends

- List

In the list (Figure 6-24) are presented all the correlated concepts categorized by type. The value in the parenthesis represents the correlation value.

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Figure 6-24: SM Correlated Concepts - List of correlated trends

- Regression Model

A linear regression model (Figure 6-25) is computed by identifying a combination of features that can best predict the curve. The Predicted curve represents the values of the regression curve, while the Data curve represents the values of the user-defined curve. While the values (Error on fitted curve, Expected error on new data, Expected error on new data of baseline) contain information about the accuracy of the generated model.

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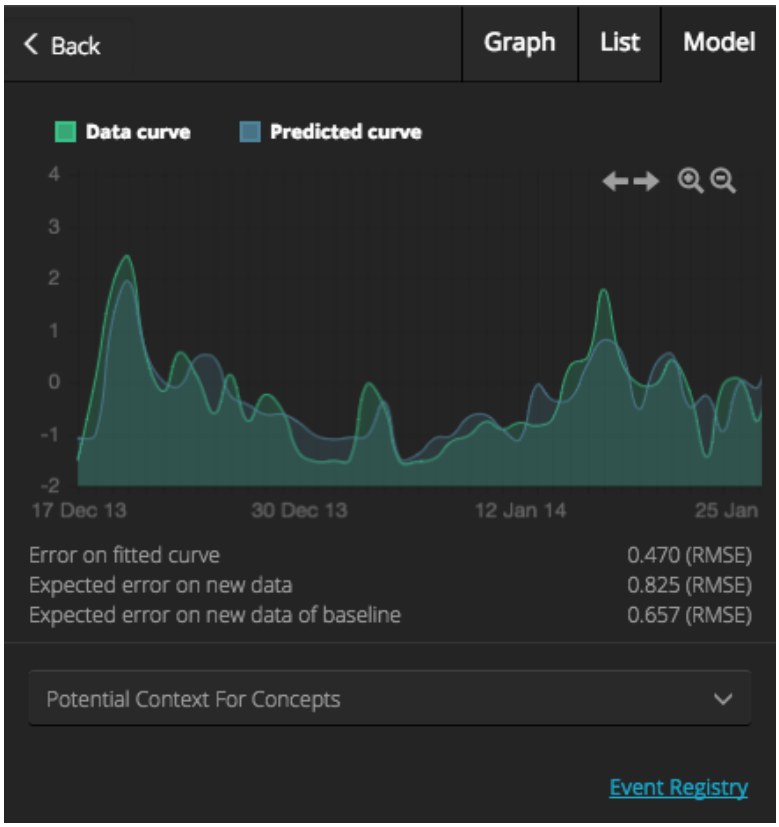

Figure 6-25: SM Correlated Concepts Widget - Regression model

Draw a curve

As mentioned, an alternative way to define a trend is by drawing a curve. So firstly the user has to define the time period, by specifying the start and end date (Figure 6-26).

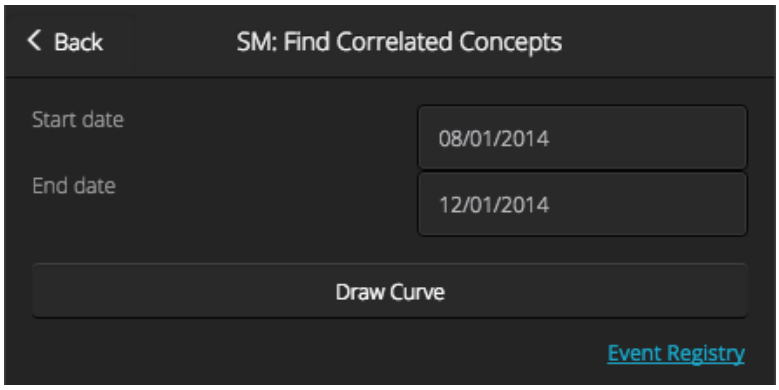

Figure 6-26: SM Correlated Concepts Widget - Set start/end date before curve draw

Then the user clicks on 'Draw Curve' button and he is redirected to canvas window (Figure 6-27) in which he can draw a curve.

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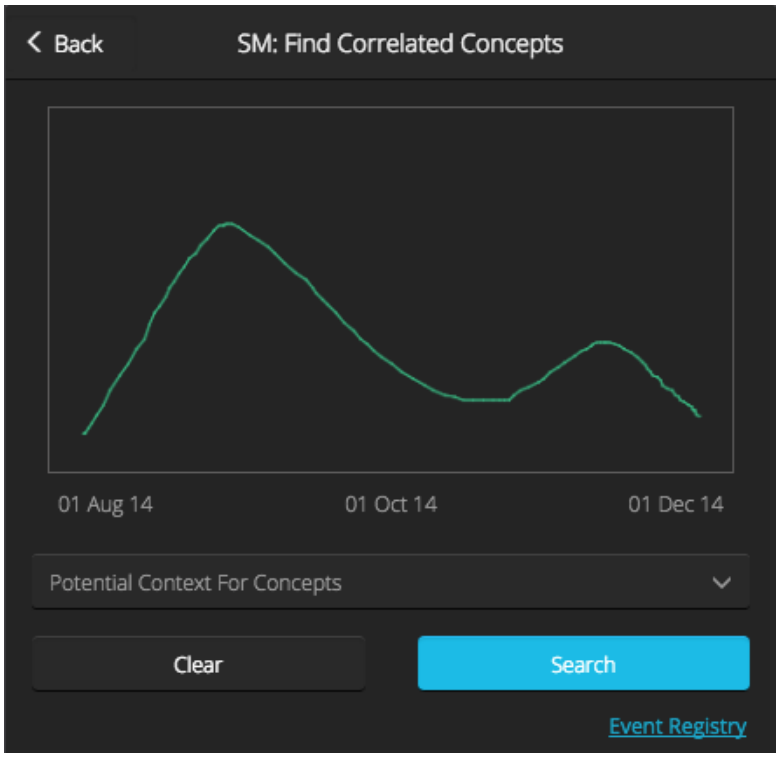

Figure 6-27: SM Correlated Concepts - Curve draw on canvas

After drawing the curve, user could clear the curve and draw another one (if he is not satisfied with the result) or he could click on 'Search' button and start finding correlated trends. After the search has completed, the user sees the correlated concepts (trends). (Figure 6-28)

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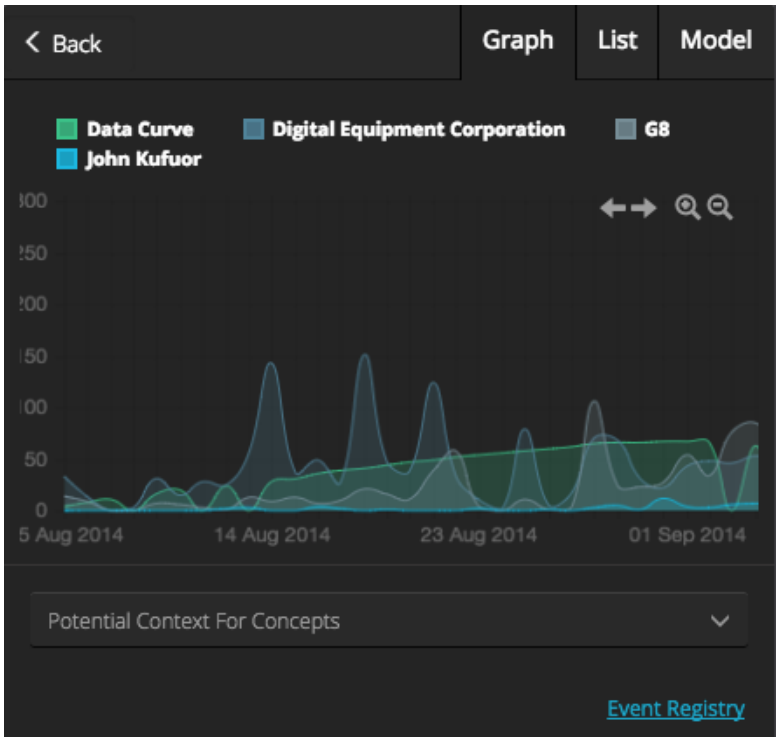

Figure 6-28: SM Correlated Concepts - Graph of top correlated trends

Import data from file

The last method for defining the trend is by importing the data from a file. The file should be a .txt file and should have two columns (Figure 6-29). The first column contains the date, while the second one contains the value (number of articles contain the trend on the specific date).

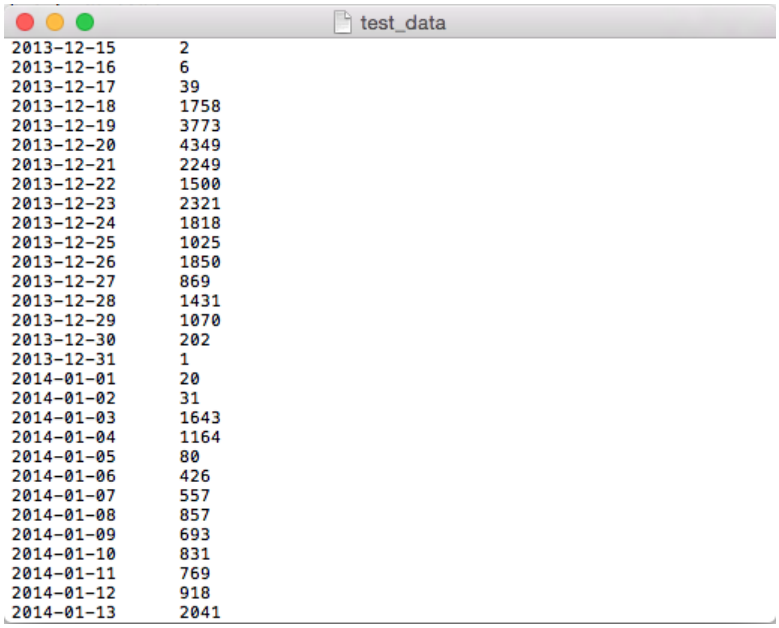

Figure 6-29: Example of trend specified in a two -columns data file

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After the user imports the file, the data is visualized and represented to the user as a graph (Figure 6-30).

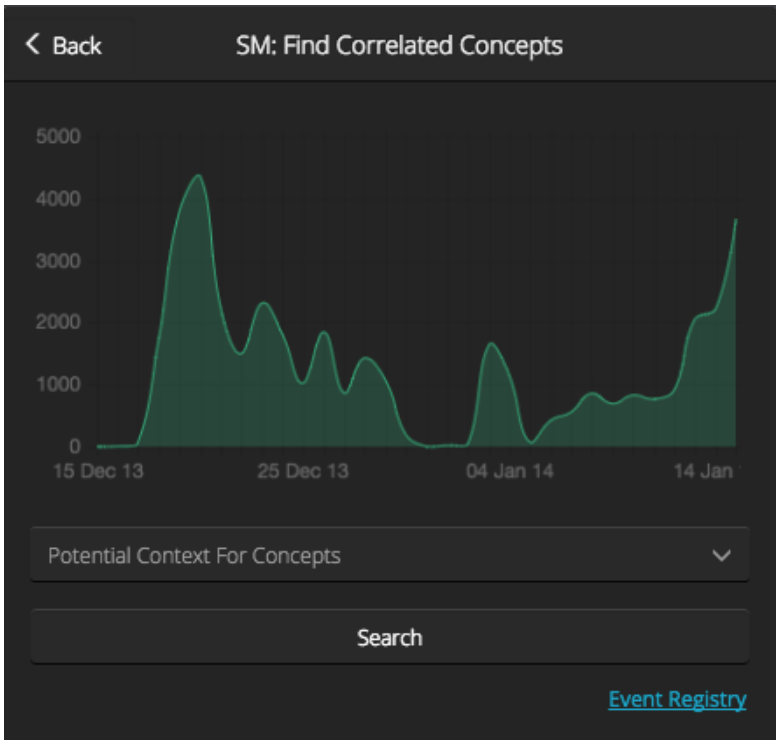

Figure 6-30: SM Correlated Concepts Widget - Visualization of file's data

Then the user clicks on the 'Search' button (Figure 6-30) and gets the correlated trends (Figure 6-31).

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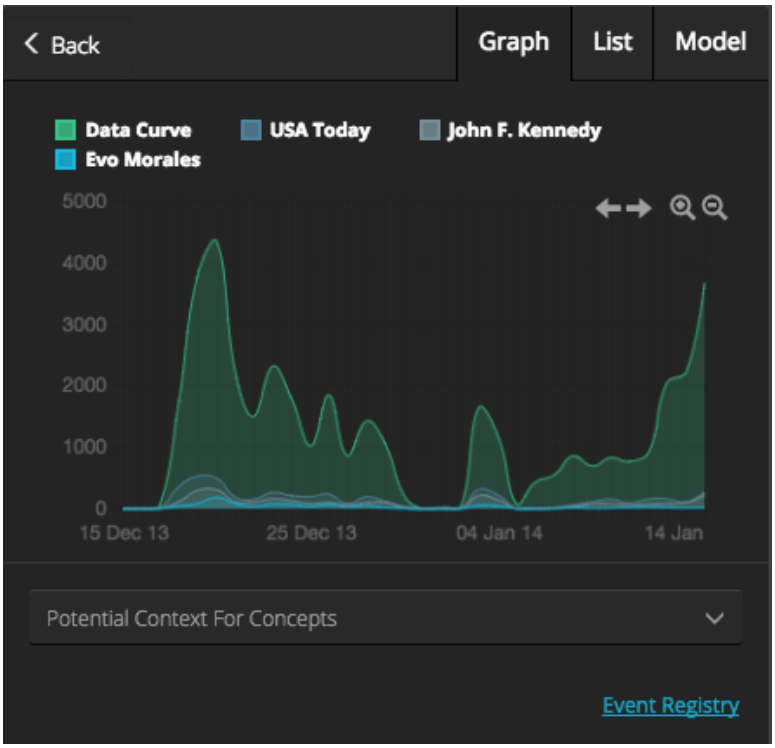

Figure 6-31: SM Correlated Concepts - Graph of top correlated trends

Game Activity Widget

The Game Activity Widget (Figure 6-32) provides data about how games' users interact with the running games. More specifically, this widget shows changes happened on agents' variables.

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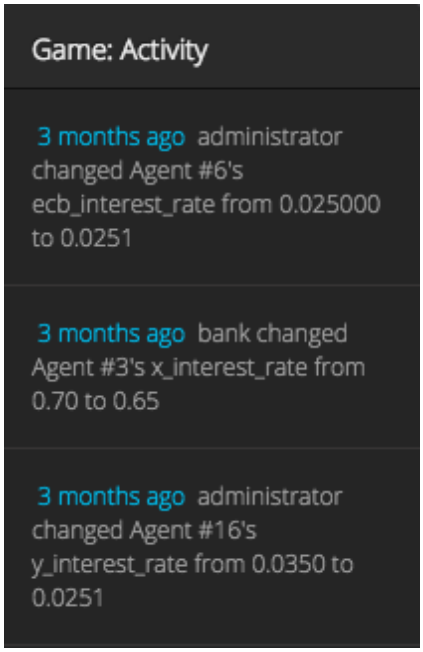

Figure 6-32: Game Activity Widget

Game Leaderboard Widget

The Game Leaderboard Widget (Figure 6-33) provides a list of game-agents ordered by reputation points.

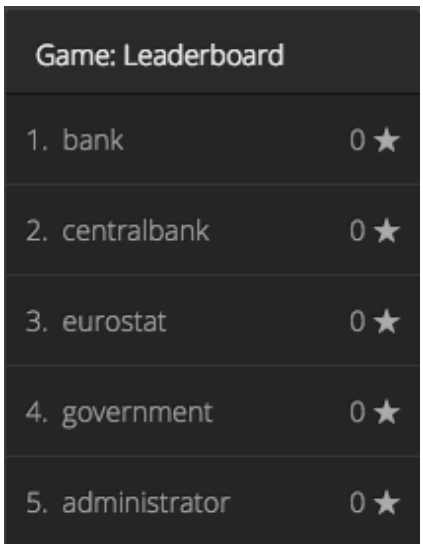

Figure 6-33: Game Leaderboard Widget

Game Statistics Widget

The Game Statistics Widget (Figure 6-34) provides statistic data about the running games. More specifically the widget consists of two parts:

- Graph

The graph represents the number of players and the number of agents in games.

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- List

The list shows statistic data per date. The user could select a date from the dropdown list and see statistic data from the selected date. The available data shown in the list consists of: number of players, number of agents, achievements earned and goals achieved.

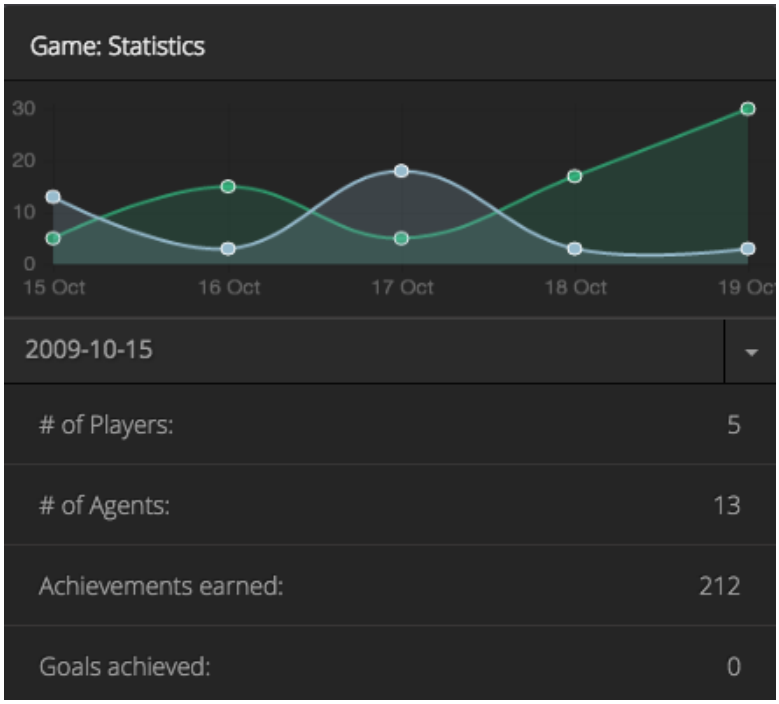

Figure 6-34: Game Statistics Widget

Game Dashboard Widget

The Game Dashboard Widget consists of two windows:

- Game List

The Game List window (Figure 6-35) displays a list of running games, by showing the game's name and description. The user should select an available role and then click on the play button in order to join the game. Whenever the user selects a role for a game, this role is not more available to other users who want to join the same game, until the user detaches the role.

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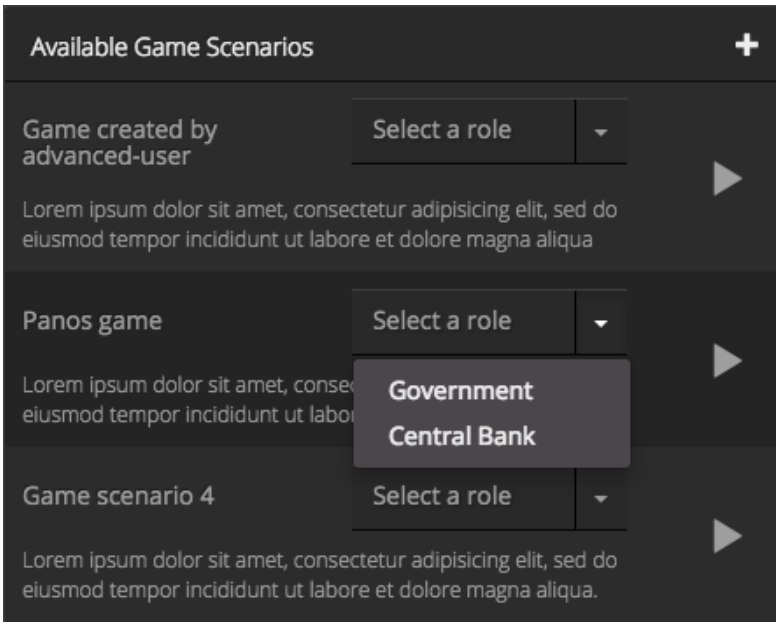

Figure 6-35: Game Widget - List of running games

- Game Configurator

The Game Configurator window (Figure 6-36) is accessible only by advanced-users and it's shown after pressing the plus button on Game List window. This window provides a form that gives user the ability to create a new game. The user should give game's name, game's description and game's duration (in days) in order to create the game. Also, the user could define some ABM module parameters before clicking the 'Create Game' button (Figure 6-37).

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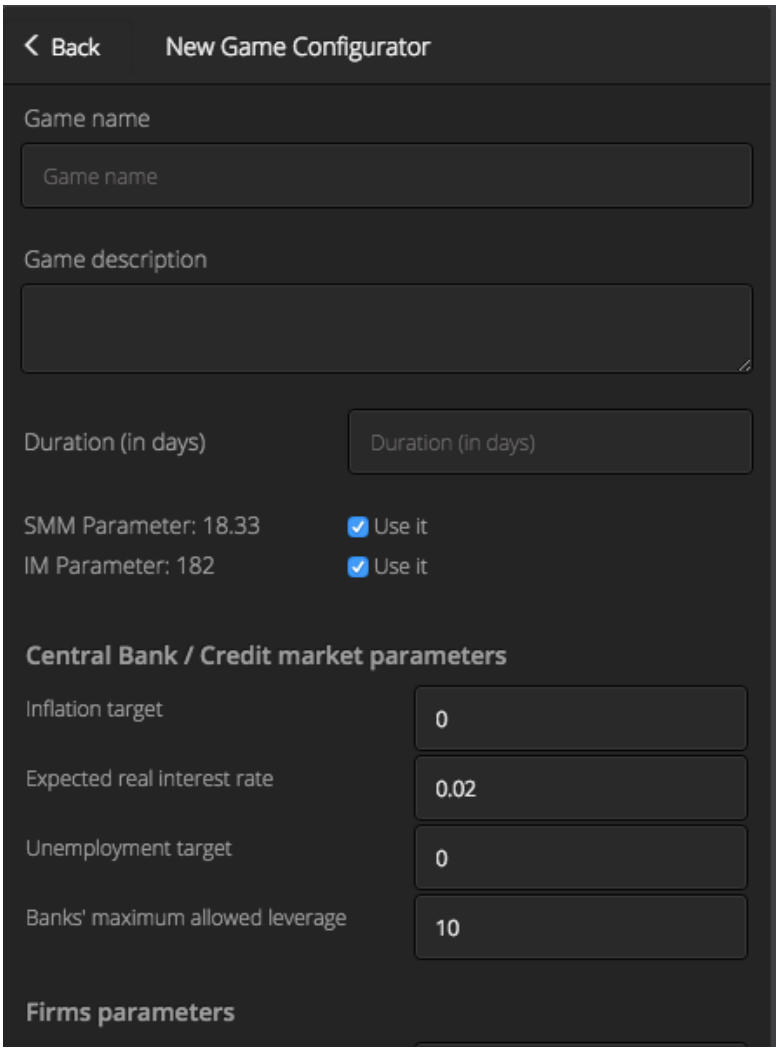

Figure 6-36: Game Widget - New game configurator (part a)

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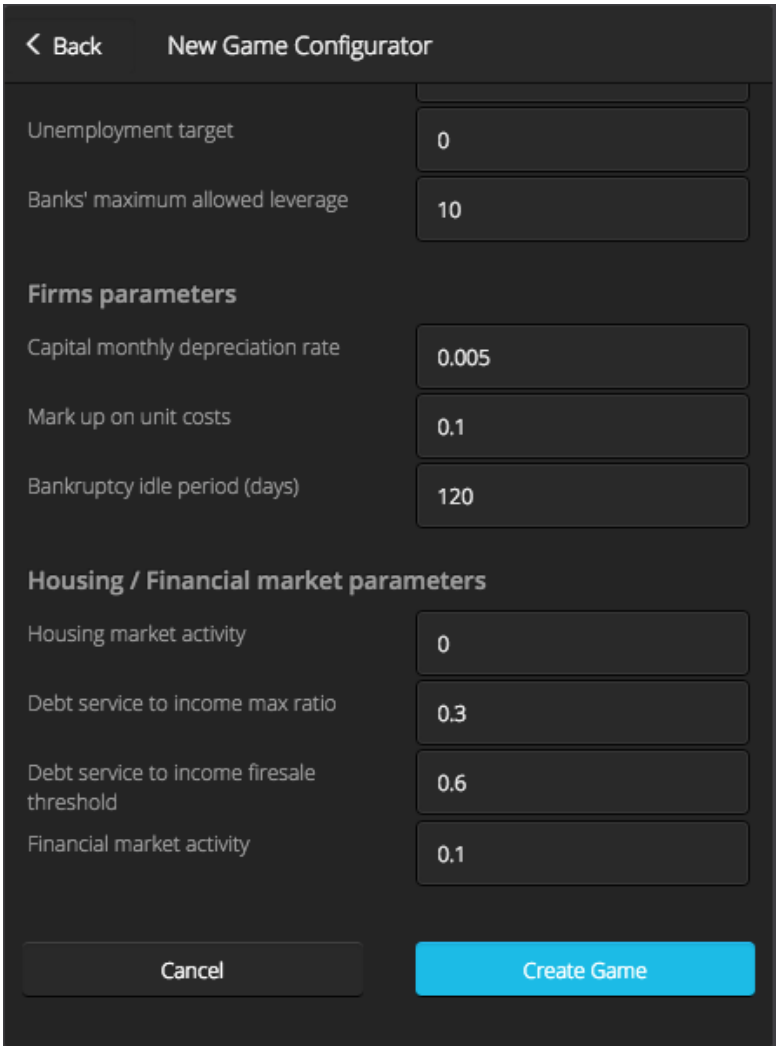

Figure 6-37: Game Widget - New game configurator (part b)

Notifications Widget

The Notifications Widget consists of two windows:

- Notification List Window

The Notification List Window (Figure 6-38) shows a list of notifications (invites) sent by the logged in user to other users. These notifications are invites that ask other users to join a created game. The icon ! means that the invited user has not joined the game yet. While the icon ✔ that the invited user has joined the game.

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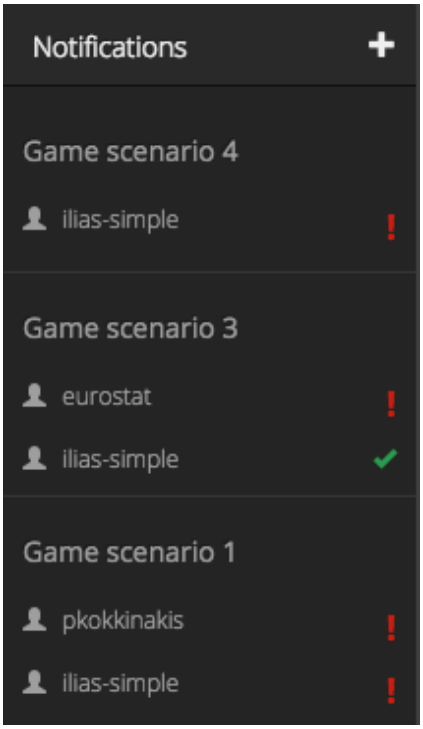

Figure 6-38: Notifications Widget - List of sent notifications

- Send Notification Window

The Send Notification Window (Figure 6-39) is accessible only by advanced-users and it's shown after pressing the plus button on Notification List window. By using the provided form, the end user selects a game (created by him), then selects the name of the user who wants to invite and clicks the 'Send Notification' button in order to send the notification (invite).

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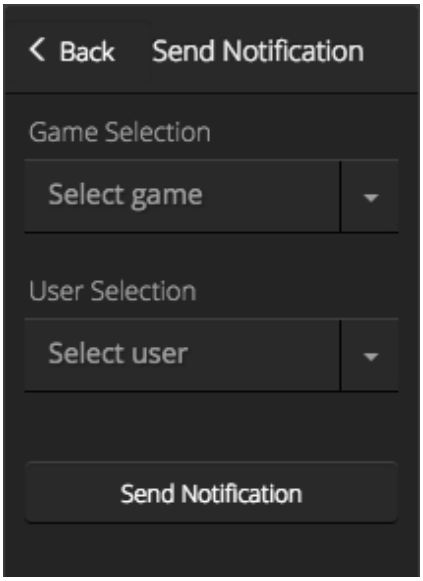

Figure 6-39: Notifications Widget - Send new notification

Users Statistics Widget

The Users Statistics Widget (Figure 6-40) provides statistic data about the dashboard's registered users. The first column shows the available user groups (system roles), while the second column shows the number of users in each group.

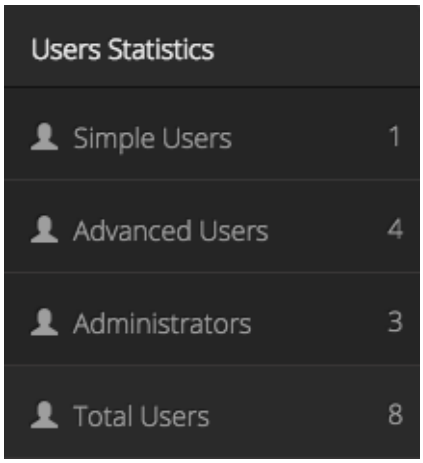

Figure 6-40: Users Statistics Widget

6.2 SYMPHONY Gamification

The below guide describes the alpha version of the SYMPHONY Serious Game which covers work done towards Task 4.2 (Game Interfaces) and Task 4.3 (Game Implementation). The game is accessible at http://game.projectsymphony.eu

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6.2.1 Game User Interface Alpha

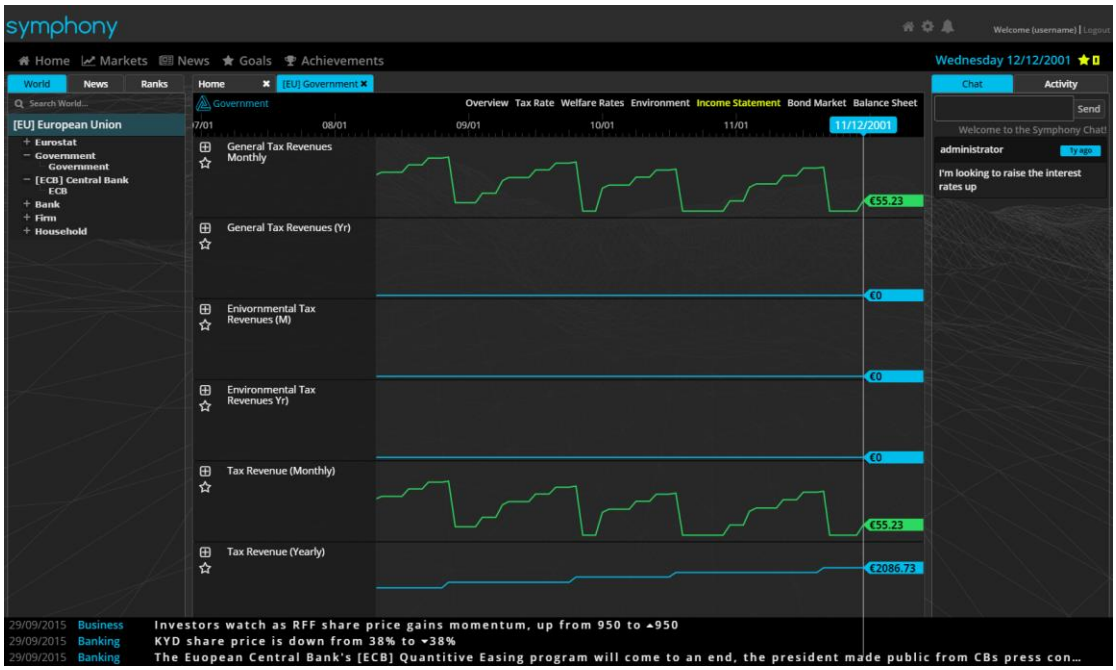

Figure 6-41: SYMPHONY GUI - Alpha Version

This is the current (Alpha) implementation of the SYMPHONY Game User Interface.

6.2.1.1 Player Types (Alpha)

In the Alpha version, players can take control of two economic players, Central Bank or Government.

Central Bank

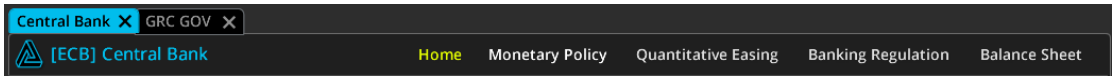

Figure 6-42: Central bank player options

The Central Bank (**E**uropean **C**entral **B**ank) determines monetary policy for a collection of countries (EU). The Central Bank player can:

Adjust the Interest Rate

- Using automatic targeting – By setting the target the system then works towards it by automatically adjusting the interest rate to meet the target condition.
    - Setting the Unemployment target
    - Setting the Inflation target
- Manually adjusting
    - Setting the interest rate value directly

Setting Bank Regulation

- Microprudential regulation, by setting maximum allowed bank leverage
- Macroprudential regulation, by setting the output gap target and credit growth target.

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Activating/Deactivating Quantitative Easing

Government

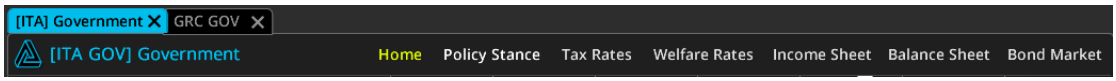

Figure 6-43: Government player options

The Government determines fiscal and monetary policy which effects all players within its sovereign; banks, firm and households. The Government player can:

Change Policy stance

- Stability and Growth Pact policy stance – with the ability to add additional features such as:
    - (+)Unemployment escape clause
    - (+)Quantitative easing
    - (+)Unemployment escape clause, quantitative easing and fiscal accommodation
- Fiscal Compact policy stance – with the ability to add additional features such as:
    - (+)Unemployment escape clause
    - (+)Quantitative easing
    - (+)Unemployment escape clause, quantitative easing and fiscal accommodation

Adjust tax rates – affects other economic players such as banks, firms and households.

- Corporate Earnings
- Labor Income
- Capital Income
- VAT

Adjust welfare rates – affects households

- Unemployment benefit
- Transfer payments

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6.2.2 Main Navigation

The main navigation allows you to quickly access key areas of the game.

Figure 6-44: Main navigation bar

6.2.2.1 Home

Figure 6-45: Main navigation bar - Home

The home option takes will direct you to your player home screen where you will be able to see your economic player statistics and favourited economic indicators. For example if you are playing as Central Bank, you will return to the Central Bank overview screen.

6.2.2.2 Markets

Figure 6-46: Main navigation bar - Markets

The Markets option will direct you to the in-game financial markets; stocks, derivatives and bonds. Markets are not a feature in the Alpha version.

6.2.2.3 News

Figure 6-47: Main navigation bar - News

Opens the news tab in the main area (see section 6.2.7)

6.2.2.4 Goals

Figure 6-48: Main navigation bar - Goals

Opens the goal tab in the main area (see section 6.2.6)

6.2.2.5 Achievements

Figure 6-49: Main navigation bar - Achievements

Opens up the achievements window (see section 6.2.8)

6.2.2.6 Date

Figure 6-50: Main navigation bar - Date

Here you can see the current date the simulation is at. Each simulation step is equivalent to one day in real time. The simulation excludes weekends focusing on just the 5 day week.

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6.2.2.7 Reputation Score

Figure 6-51: Main navigation bar - Reputation Score

Your reputation (star icon) earn is displayed here. You gain reputation by completing Goals and Achievements. You lose reputation when bad decisions lead to negative effects in the economy.

6.2.3 Left Side Panel

6.2.3.1 World

Figure 6-52: World Panel

The World panel allows you to explore each player within the simulated economy. Use the branching tree view to sort through Central Bank, Governments, Banks, Firms and Households. You can also use the search option if you want to find a player quickly.

6.2.3.2 News

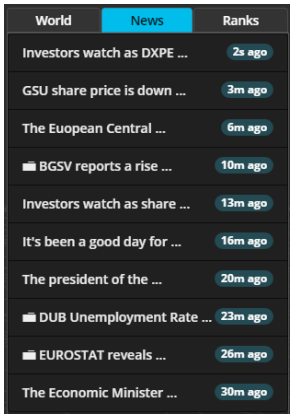

Figure 6-53: News Terminal Quick View Panel

The News Tab displays reports from economic players, the panel version allows you to play in the main area without having to open a new tab to access the news terminal.

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6.2.3.3 Ranks

Figure 6-54: Ranks Panel

The Ranks tab displays the currently ranks among all players in the economy. In Alpha only human players are displayed, however Beta will provide the addition of display AI player ranks. Players are ranked using a set of key indicators, these include:

- **Reputation count** – The main measurement within the game. Reputation is earned for completing goals and achievements. The player loses reputation if they make a bad decision causing problems in the economy for other players.
- **GDP value** – Government players are measured by their GDP value.
- **Wealth count** – Bank, Firm and Household players are measured by their wealth. Equity and Cash amount are wealth indicators.

6.2.4 Right Side Panel

6.2.4.1 Chat

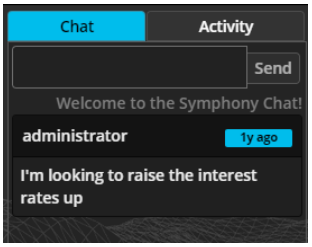

Figure 6-55: Chat panel

The in-game chat system allows you to communicate with other human players. The date and time stamps relate to the in game simulation time to avoid confusion between simulated and real time.

6.2.4.2 Activity Feed

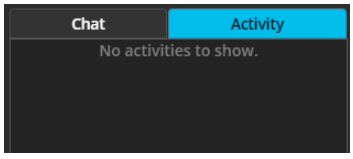

Figure 6-56: Activity feed

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The activity feed displays all human player activity within the game. Activity is reported when a player changes an indicator value. For example when the Central Bank player raises the interest rate this is reported in the activity feed along with the current and new rate increase. The fully functional Activity Feed will be available in the Beta version.

6.2.5 Main Area

Figure 6-57: Main area

You will spend most of your time in the main area, this is where you can make crucial decisions, monitor your finances, gain access to other player data and enter markets.

6.2.5.1 Navigation

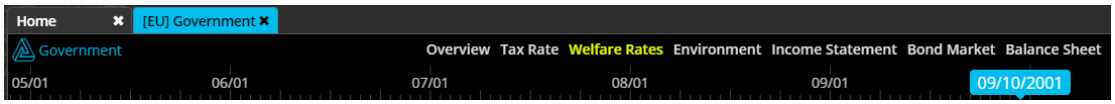

Figure 6-58: Main area - navigation

The navigation section for the main area allows you to filter between certain pages of information for each player.

Player sections

Figure 6-59: Main area - player sections

Player sections allow you to filter and sort economic indicators. Many players will have multiple player sections which will include sections such as Income Statement, Balance Sheet and an Overview.

Timeline

Figure 6-60: Main area - timeline

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Displays the date along the top of the main area. Each economic indicator relates to the timeline. The current/selected date can be seen highlighted in blue.

6.2.5.2 Controls

Figure 6-61: Main area - player controls

Viewing your own player sections will display controls. Here you can make your policy decisions. This is where most of the critical decision making takes place in the game, this is where you change the economy.

6.2.5.3 Economic Indicators

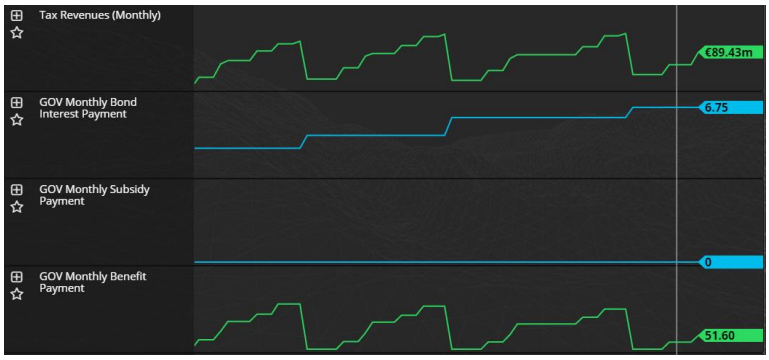

Figure 6-62: Main area - economic indicators

Indicators display the key economic values per each player. Each indicator is displayed as a line graph with a historical plot. As each simulation step passes the indicator values are drawn to the dynamic graph.

Details

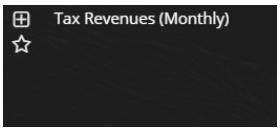

Figure 6-63: Main area - economic indicators, details panel

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This panel provides you with basic information about the indicator. From the details panel you are able to view more information about the indicator by using the (+) button or if you want to keep track of this indicator you can favorite it (star) – adding the indicator to your player overview (home) screen.

Graphs

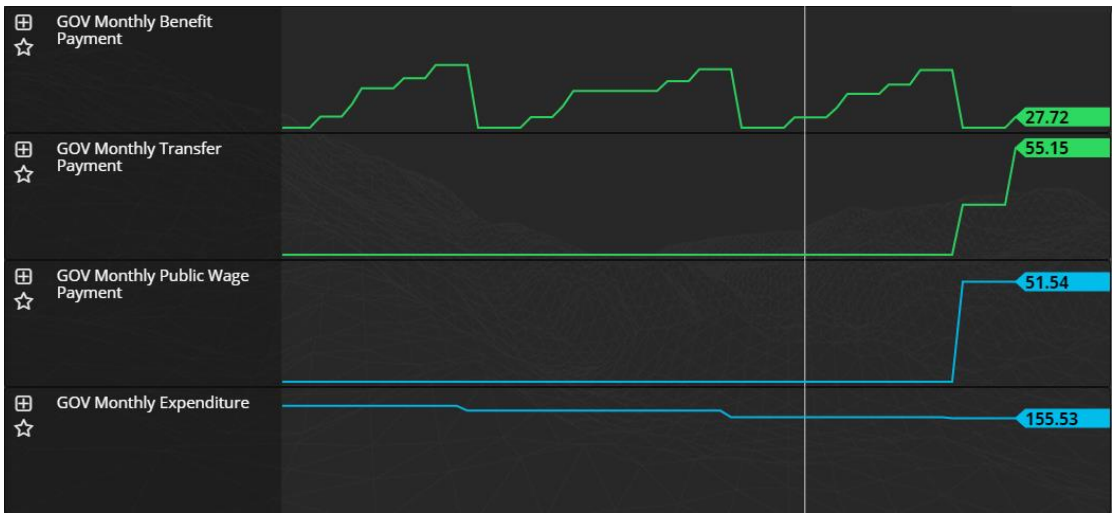

Figure 6-64: Main area - Graphs

Positive Change

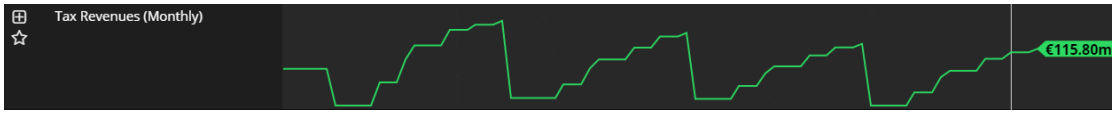

Figure 6-65: Main area - graphs, positive change in value

When an indicator's value is positive as a result of the value increasing since the last stimulation step, the graph color will turn green.

Negative Change

Figure 6-66: Main area - graphs, negative change in value

When an indicator's value is negative as a result of the value decreasing since the last stimulation step, the graph color will turn red.

No Change

Figure 6-67: Main area - graphs, no change in value

When an indicator's value hasn't changed as a result of the value staying the same since the last simulation step, the graph color will turn blue.

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Historical Value Display

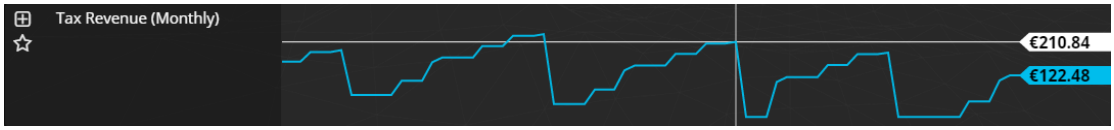

Figure 6-68: Main area - graphs, historical value display

Clicking on a point on the graph displays the historical plot (white). Allowing you to view previous historical values.

6.2.6 Goals

Goals provide progression within the game. Once you log in you will be given a specific goal (based on your player type). From the goals screen you will see all your current goals which have been assigned to you. The Alpha interface

6.2.7 News Terminal

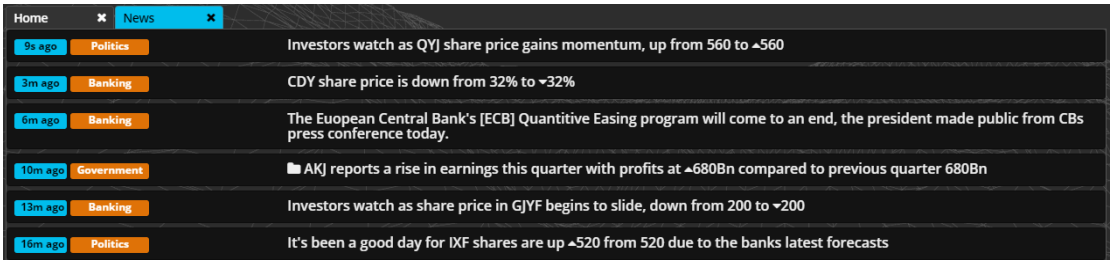

Figure 6-69: News Terminal

The News Terminal provides you quick insight into how the simulated economy is doing via generated news reports from each of the economic players in the simulation scenario. Every step each economic player reports changes in their current stance. For example if the Central Bank player raises the interest rates, it will be reported in the next step. It may look similar to this "*The president of the European Central Bank [ECB] today in Brussels revealed plans to reduce the Interest Rate from 0.05 to ▼0.25%.*"

The news is broken down into a number of categories which help sort and manage report types, these are:

- **Politics** – Displays news from Central Bank and Government players

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- Government
  - Reports earnings, deficit and surplus
  - Reports welfare and tax rate changes.
- Central bank
  - Reports Interest Rate changes, including inflation target and unemployment target.
  - Reports quantitative easing programme state
  - Reports banking capital requirements.

- **Banking** – Displays news from Central Bank and Bank players
  - Bank
    - Reports stock price, dividends, dividends per share
  - Central bank – (same as above – see Politics)
  - Credit Market
    - Reports shocks and drastic changes in the credit market to warn banking players.

- **Markets** – Displays news from Central Bank, Bank and Firm players
  - Firm
    - Reports stock price, dividends, dividends per share
    - Reports profits
    - Reports Mall sales figures
  - Bank
    - Reports stock price, dividends, dividends per share
  - Central bank – (same as above – see Politics)
  - Financial Markets
    - Stocks
      - Reports Index Value
      - Reports yearly and daily stock market index returns
      - Reports Top 10 Market Gainers

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        - Reports Top 10 Market Losers
    - Bonds
        - Reports Bond Values and Yields

- **Economy** – Displays news from EuroStat, Government and Central Bank players.
    - EuroStat
        - Reports price index, price growth, average price level
        - Reports EU real and nominal gdp, deficit/GDP ratio, debt/GDP ratio
        - Reports total consumption and investment
        - Reports yearly and daily stock market index returns
    - Government – (same as above – see Politics)
    - Central bank – (same as above – see Politics)

6.2.8 Achievements

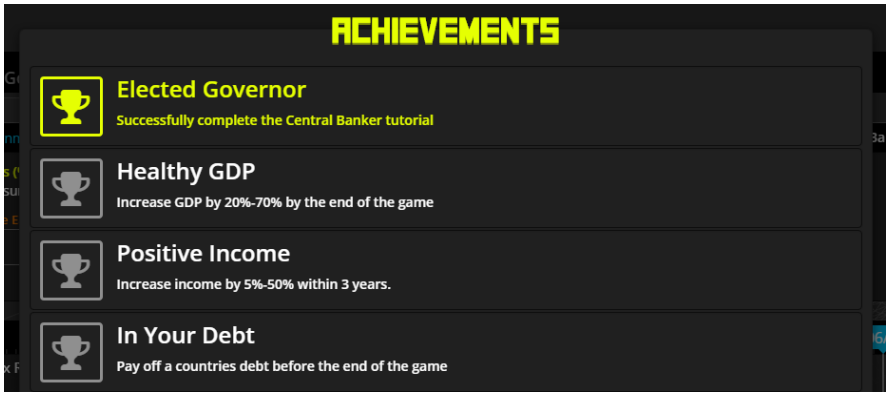

Figure 6-70: Achievements

Achievements provide an added value to the platform, more of mini-goals which players can work towards outside of their main goals. Achievements show off how well a player has progressed during their lifetime on the SYMPHONY platform. Players are awarded achievements for doing positive and negative actions such as;

- **Survive a recession** – when a recession hits the economy the player needs to survive it through any means necessary.
- **Crash the economy** – if certain actions of the player lead to the economy deaerating rapidly.
- **Within Top 5 GDP** – Government player ranks within the top 5 countries in the simulator with GDP as the measured indicator.

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7 Security & Privacy Requirements

7.1 Security aspects

The SYMPHONY platform offers functionalities to model the economy and perform simulations that support policy makers and policy modelers to understand the effects of their policies as well as to nowcast information with the use of social media mining analytics and information aggregation with the use of information markets. In general, the SYMPHONY toolset does not involve access and processing or manipulation of sensitive and confidential data. This means that the implementation and integration of advanced security related protection mechanisms are not in the scope of the SYMPHONY project.

However, we have considered all the appropriate security and safety measures in order to protect the application and its users from malicious attacks and mitigate the risks associated with using information technology and preserve user privacy.

All the tools as well as the actors which require protection have been identified and the potential threats and vulnerabilities of the system have been defined. A set of roles have been specified in line with the SYMPHONY scenarios described in D1.1 [2]; these cover the functionalities and expectations of the tools.

In SYMPHONY we have used the standardized security concepts defined in [ISO/IEC 27002]: confidentiality, integrity, authentication, authorization, non-repudiation, and availability.

Although security goals are never absolute and it is not possible to guarantee 100%, our efforts are targeted towards designing and implementing an adequate security model and ensure acceptable levels of security risk. In the following sections we describe how the main security concepts are addressed in the SYMPHONY platform.

7.1.1 AAA (Authentication, Authorization and Accounting)

In general, Authentication, Authorization, and Accounting (AAA) provide the framework for intelligently controlling access to computer resources, enforcing policies, auditing usage, and providing the information necessary to bill for services. These combined processes are considered important for effective application management and security.

In more details, authentication concerns the identity of the participants and refers to the means by which one participant can be assured of the identity of other participants. Authorization ensures the legitimacy of interactions and refers to the means by which an owner of a resource may be assured that the information and actions that are exchanged are either explicitly or implicitly approved. Accounting allows to measure the consumed resources on a user-resource level (note that accounting of resource usage is not relevant for SYMPHONY).

In SYMPHONY we have defined a framework for user authorization and access rights management, and we rely on a single-sign-on methodology for user authentication.

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The SYMPHONY dashboard provides a loosely coupled integration of the toolset and offers users the option to select which of the functionalities to use based on their interests and role within their organization. For example policy makers and policy modelers (advance users) are interested to configure and setup the simulated economy whereas other stakeholders are interested to participate in the simulation through the gamified interface. Moreover policy makers and policy modelers are interested to nowcast information by configuring questions in the information market while other stakeholders participate in the market and provide their personal information through trading actions. The social media mining functionalities are mostly interesting to policy makers and policy modelers, however other stakeholders may want to access the related functionalities and gain insights on what is happening in the economy in near real time.

Having in mind the above, the SYMPHONY conceptual architecture described in D1.1 [2] and the technical architecture described in D5.1 [7] we have defined a Role-Based Access Control (RBAC) generic framework for access rights management (see Figure 1). The basis of RBAC is the concept of a role which constitutes a grouping mechanism for categorizing individual users (called subjects) based on various properties (e.g. job title, user functions, responsibilities etc.). Each subject has an authorized role set, which consists of all the roles that the subject has been authorized to use. RBAC is very useful and widely spread for modelling access control in a variety of applications.

The functionalities in SYMPHONY are represented by the following tools:

- Information Market
- Social Media Mining
- SYMPHONY Game
- Agent Based Model
- SYMPHONY Dashboard

The access rights can be one of the following:

- View only. Users cannot edit or configure the related tool.
- Simple-User. Users can use the tool but cannot configure it. This role includes players in the game and traders in the information market.
- Advanced User. Users have full control of the tool. They are the policy makers and policy modelers who configure the simulated economy, the game and the information market.
- Administrator has the privileges of the advanced user as well as additional privileges such as the creation of new user or Delete existing user or change a user's role.

With respect to the single-sign-on framework that has been address by the Access Control and Identity Management component, this is described in section 2.2 and has been adopted by all the tools comprising the SYMPHONY toolset.

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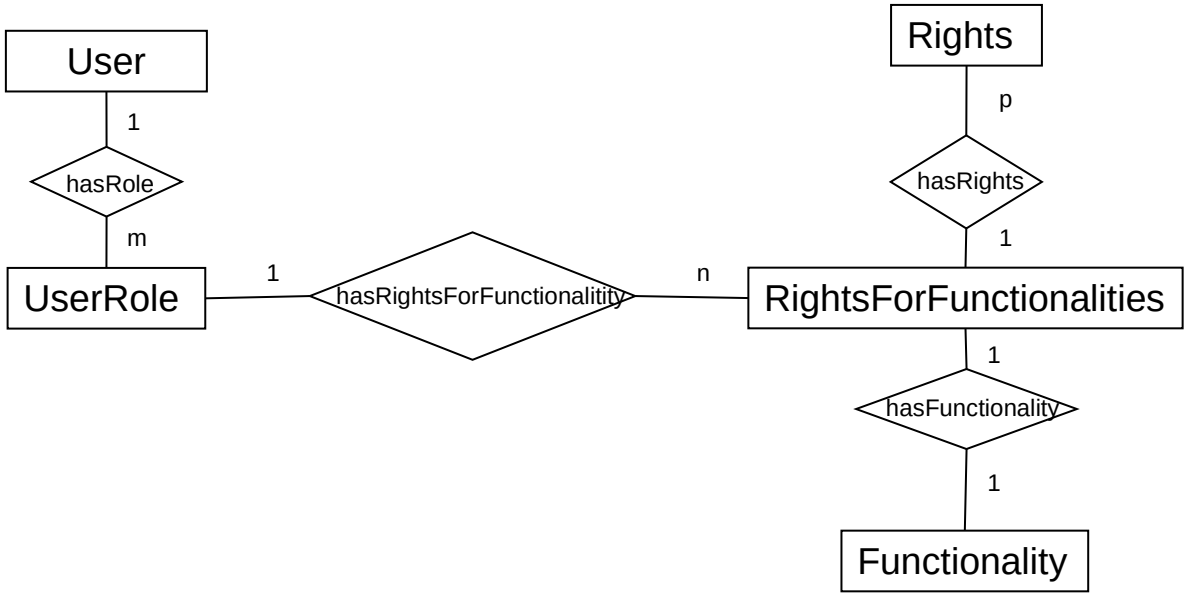

Figure 7-1: The SYMPHONY generic access rights framework. Users can have one or more UserRoles; each UserRole has one or more rights for Functionalities

7.1.2 Availability

Availability refers to the ability of systems to offer the services for which they were designed. One of the threats against availability are "denial of service" attacks in which attackers attempt to prevent legitimate users to access the system.

The SYMPHONY platform relies on the underlying infrastructure to provide the means which should protect the application from denial of service attacks. System administrators of the infrastructure where SYMPHONY resides should take all the required precautions such as offering adequate bandwidth and processing power to avoid service outage and securing the infrastructure at a network level by filtering data packets from obvious sources of attack, drop spoofed or malformed packages etc.

7.1.3 Confidentiality

Confidentiality refers to the protection of the privacy of users in their interactions and assures that unauthorized entities are not able to read messages or parts of messages that are transmitted. Note that confidentiality has degrees: in a completely confidential exchange, third parties would not even be aware that a confidential exchange has occurred. In a partially confidential exchange, the identities of the participants may be known but the content of the exchange obscured.

In SYMPHONY we rely on confidentiality measures offered by the underlying infrastructure. In more details, as the platform comprises of a set of web applications, system administrators are encouraged to configure access to the system through secure https connections and with valid certificates issued by authorized and trusted organizations.

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7.1.4 Integrity

Integrity provides the means to protect the exchanged information from unauthorized writing or inadvertent corruption. Integrity ensures that the exchanged information has not been altered.

Similarly to the case of confidentiality, SYMHPONY relies on the underlying infrastructure and network or transport layer protocols (https is the preferred solution) to provide the necessary data integrity.

7.1.5 Non-repudiation

Non-repudiation refers to the accountability of users and provides the means to foster trust in a system used to conduct shared activities. This concept ensures that users are not able to deny (repudiate) their actions, e.g. deny having participated in an interaction or having performed actions as reported by other users.

In SYMPHONY each component may track and log the actions of users in the platform in order to ensure non-repudiation. For example all of the transactions in the Information Market are recorded and stored in the database together with a unique id and timestamp. For more details see deliverables D2.2 [3], D2.3 [4], D3.2 [5] and D4.2 [6] describing the details of the components.

7.1.6 Security Risks

Following the above security approach, the below security risks have been identified for the SYMPHONY platform:

7.1.6.1 Risk: Insecure access control

Likelihood: Low / Impact: High
Description: A common requirement of most multi-user information systems is to provide a mechanism for access control. Access control comprises identification, authentication and authorization. By providing insecure access control mechanisms in SYMPHONY, registered users, advance users, and administrators might be able to access information of other users in the system. Furthermore, an attacker might get access to the SYMPHONY platform, which would enable him to use data that are not publicly available, misconfigure system settings or gain access to services like advanced data insights.

7.1.6.2 Risk: Identity theft

Likelihood: Medium / Impact: High
Description: Identity theft is about an attacker who pretends to be someone else. This is a serious risk, especially in an environment like SYMPHONY where different types of user roles. An attacker gaining access to the SYMPHONY platform as an existing user would have access to the user's profile and portlets. If stolen identity is gained by theft, the attacker could alter the configurations of the user profile, experiment with data that he is not permitted to access and even take advantage of his ideas.

7.1.6.3 Risk: Data Leakage

Likelihood: Medium / Impact: Medium
Description: Data leakage refers to unauthorized third parties gaining access to personal or business-related data. Depending on the feedback and the granularity of the data, an attacker might have access to a large number of personal/business data records. The

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SYMPHONY platform will maintain private analysed sets of data which can be used for advanced insights. Leakage of such data could expose SYMPHONY related information that might be of high security risk or jeopardise the competitive edge of a user trying to shape is personal data.

7.2 Privacy aspects

Privacy refers to the proper handling of personal information and respecting the dignity of the individual who interacts with the system. In SYMPHONY we do not deal with personal user sensitive information. Besides a username, email and password no other personal information is mandatory to be provided by the users. Moreover it is at the discretion of the user to reveal her/ his real life identity to the platform (by e.g. providing a username that points to a real life identity).

In any case, in order to reduce the risks of privacy compromises the SYMPHONY database where all user related information is stored are deployed at a secure environment with all required security precautions.

For the purposes of the SYMPHONY, ATC has set up the below privacy policy that will be applied for the SYMPHONY platform.

7.2.1 Privacy Policy

7.2.1.1 Introduction

SYMPHONY recognizes that users' privacy is very important to them and that they have the right to control their personal information. The consortium know that providing personal information is an act of trust and we seriously take that into account. This privacy policy forms part or our Terms of Use (TOU) and should be read with our TOU. Users' email address will NEVER be public displayed on this website. We will not email you anything unrelated to the SYMPHONY. If users' email address is supplied, it will be stored securely.

7.2.1.2 Collection and use of personal information

SYMPHONY collects information at different points on our website. The two main points for the information collection are, either when new members join SYMPHONY.

Members: When you become a member of SYMPHONY platform, users' provide us with their name and email address. SYMPHONY is the sole owner of this information and we will not sell, share, or rent this information with any other company or individual in ways different from what is disclosed in this statement. From time to time, we may share users' information with others on an aggregated basis. The Consortium will not share information in such a way that it can be linked to an individual.

Ad Services: In addition, some user information may be collected by third-party ad services. Users always have a choice of whether to supply their information or not, but in no case this information will be collected without being properly informed. SYMPHONY does not maintain any control over the information supplied to these ad services and this information will be used in accordance with the privacy policies of these outside services. SYMPHONY

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may use these services in order to allow the consortium to keep supplying free and subsidized services. We have screened external privacy policies to ensure that personal user information is not misused, but we encourage users with concerns to contact us directly.

Exception: SYMPHONY may disclose user information, when we have reason to believe that disclosing this information is necessary to identify, contact or bring legal action against someone who may be violating our Membership Agreement or may be causing injury or interference, intentionally or unintentionally, to the SYMPHONY's rights or property, other SYMPHONY users, or anyone else that could be harmed by such activities.

7.2.1.3 Cookies

A cookie is a piece of data stored on the user's hard drive containing information about the user. Usage of a cookie is in no way linked to any personally identifiable information while being on our site. Once the user closes his/her browser, the cookie simply terminates. For instance, by setting a cookie on our site, the user would not have to log in a password more than once, thereby saving time while visiting our site. If a user rejects the cookie, he/she may still use our site. The only drawback to this is that the user may be limited in some areas of our site. Cookies can also enable us to track and target the interests of our users to enhance the experience on our site. Some of our business partners use cookies on our site (for example, advertisers). However, we have no access or control over these cookies.

7.2.1.4 Information security /Information Disclosure / Sharing

The SYMPHONY platform takes every precaution to protect our users' information. When users submit sensitive information via the platform, their information is protected both online and off-line. Any information they provide will be held securely and in accordance with the Data Protection Act 1998. Their personal details will not normally be disclosed to third parties. In some circumstances however the consortium may need to disclose their personal details to a third party, so that they can provide a service you have requested, or fulfil a request for information. Any information about the users that SYMPHONY pass to a third party will be held securely by that party, in accordance with the Data Protection Act 1998, and used only to provide the services or information users have requested. Users have the right to access the personal information the platform holds about them at any time.

7.2.1.5 Access to personal information records

SYMPHONY provides personal data access rights to all who leave personal information on the SYMPHONY platform. SYMPHONY respects the data access rights of those who entrust information to the SYMPHONY platform. SYMPHONY complies with International protocols in this regard. International standards allow for small administrative fees to be applied in some cases, where records are requested.

7.2.1.6 Changes to this privacy policy

If this privacy policy changes in any way, the consortium will place an updated version on the privacy page of the platform. Regularly reviewing this page ensures that users are always aware of what information we collect, how the consortium use it and under what circumstances, if any, SYMPHONY will share it with other parties.

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7.3 Open Data Policy for SYMPHONY

Due to potential open data policy issues that SYMPHONY is going to face, the consortium has decided to adopt the following Open Data Policy in order to license the data that are being generated at the SYMPHONY Platform as a whole.

"*This work and data by SYMPHONY project is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License*[10] [ANNEX I]*. Its license refers exclusively to data generated by Event Registry algorithms, available through the Event Registry API, and used in the SYMPHONY (FP7-ICT- 611875) project of the ICT Programme of the EC. This license does not apply to any third party content, such as news articles, which are the copyright of their respective publishers and must be used in accordance to their respective licensing terms. This license does not apply to any other content created or modified by the SYMPHONY consortium for the SYMPHONY project such as software or the Event Registry website available at http://eventregistry.org*[11]*."*

[10] http://creativecommons.org/licenses/by-nc/4.0/

[11] http://eventregistry.org

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8 Conclusions and Next Steps

The first integrated prototype of the SYMPHONY platform has been successfully deployed and will be evaluated by a group of users in the following period. The implementation and integration is not limited to the current level. Most research modules, as well as the platform itself are designed to be flexible and easily customizable. The overall architecture of the system facilitates modifications and makes the platform improvement to be easy, at any point. This will be the aim of the following period: to continue the enhancement of this platform capabilities, make it more stable, more sophisticated and more efficient for the target end users, by plugging additional functionalities and calibrating existing ones.

The future steps include the assessment of the feedback that will be received and also the integration of the next versions of the components as planned according with the description of work.

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[7] D5.1 Definition of System Architecture

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ANNEX I

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