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Organizational Social Networking using SNARE

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Abstract

A social network represents a set of social entities that interact through relationships like friendship, co-working, or information exchange. Social Network Analysis studies the patterns of relationships among social entities and can be used to understand and improve group processes. The arrival of new communication and networking platforms, especially the Web 2.0 Social Networking Services, opens new opportunities to explore the power of social networks inside and outside organizations.

In this dissertation we present SNARE (Social Network Analysis and Reengineering Environment) a common platform to extract, discover, instantiate, and analyze social networks and that is able to create and support organizational communities. Based on a common Social Network Model that represents social networks containing a set of social entities, relation, roles and properties adapted to different organizational contexts, several applications were developed. SNARE is constituted by a service core where a front-end web application connects to allow members' and managers' interaction, featuring social network management, organizational survey and community creation. It was used to discover a social network in a case study at Vodafone Portugal by automatic analysis of surveys with different inferences.

Based on these social networks, active communities can be created enabling personal spaces as members' profiles with details and roles, and public spaces directed to groups of entities with common interests or situations. In a case study about a community of former students (POSI) we explain how people can interact, using these communities to easily find information about peers and possible interesting new connections.

Keywords

Social Networks

Social Network Analysis

Social Networking Services

Collaborative Communities

Resumo

Uma rede social representa um conjunto de entidades sociais que interagem entre si, através de relações de amizade, de trabalho ou de partilha de informação. A análise de redes sociais estuda os padrões de relações entre entidades sociais e pode ser usado para compreender e melhorar processos de grupo.

Nesta dissertação apresentamos o projecto SNARE (Social Network Analysis and Reengineering Environment) uma plataforma para a extracção, descoberta, instanciação e análise de redes sociais. Baseado num modelo comum que permite a representação de redes sociais, contendo um conjunto de relações adaptadas aos diferentes contextos organizacionais desempenhadas por um conjunto lato de entidades socais personalizadas por conjuntos de propriedades dinâmicas, diferentes aplicações foram criadas. A plataforma é consituida por um nucleo de serviços onde uma aplicação web se conecta para permitir a interacção de gestores e membros. Foi usado para descobrir a rede social implícita existente num caso de estudo desenvolvido num departamento da Vodafone Portugal, através da análise de questinários onde as respostas dadas foram automaticamente mapeadas para o modelo de rede social definido.

As redes sociais criadas podem funcionar como comunidades activas com espaços privados como perfis pessoais e espaços comuns constituídos por grupos de entidadades agrupadas por um conjunto de interesses ou situações comuns. Baseado num caso de estudo desenvolvido numa pós-graduação leccionada pelo Instituto Superior técnico é explicado como é que o uso destes espaços pode exponenciar a interacção entre colegas, e permitir a descoberta de novos contactos dentro de uma organização

Palavras-chave

Redes Sociais

Análise de Redes Sociais

Serviços de Social Networking

Comunidades colaborativas

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1. Introduction

This dissertation describes the work developed during one year at the Information Systems Groups at Inesc-Id Lisboa, regarding the Master Thesis in Information Systems, in a project about organizational social networks and its applications in information systems. Along this report, the background information about this field of study is introduced together with the motivation and goals that lead to this project development. In a technical view, starting from the platform architecture we describe its high-level design ending on each functionality interface and respective working mode. Finally two case studies where the project was applied are described and evaluated. The appendixes contain useful information for understanding complementary details present in the text.

1.1. Context

Social Networks are not a totally new concept, in fact its study started around the 1930's influenced by work done in the fields of sociology, anthropology, mathematics, networks, and graph theory [2]. Generally, a social network is defined as a set of actors and the relationship(s) defined among them and is used to represent a set of social entities that interact through relationships like friendship, co-working, or information exchange. Social Networks can be found wherever relations among social entities are present and its study can be valuable to understand general structure and group processes.

Social Network Analysis (SNA) represents a method for achieving analytical results about almost any group interaction. Different measures are defined to analyze network cohesion, density and dimension, and to individually analyze each actor importance and influence in the social network [2].SNA can be used in different areas like general organization improving [1], economy [3], health [4, 5], politics [6] and marketing [7] and in different academic fields. However, SNA applied in organizational engineering, named Organizational Network Analysis(ONA) represents its major application helping in evaluating the connections between employees, or groups like departments and functional areas inside organizations [1]. Namely, ONA can be helpful to support partnerships and alliances, by understanding common integration aspects and behaviors. Moreover, it can analyze the integration between networks, strategy and core processes, determining key members in the network and depicting how people really interact inside the organization.

The arrival of computational methods driven SNA to a new analysis level where hundreds of entities and relations can be depicted using software platforms. Nowadays panoply of software exists to visualize, manage and analyze social networks. Social network tools can be divided in four categories according to their main scope: analysis tools [8-11], visualization tools [8, 10], extraction data tools [12] and survey analysis tools[13-15]. Analysis software receive a defined input format, usually a matrix with the relations among entities and output a set of important measures that can compare network structure or each actor

importance. Visualization software permits to display graphs where entities are disposed according to its relations and influences inside the network. This kind of tools allows to visually identify central and peripheral entities and to generally understand social network structure. Extract, Transform and Load (ETL) tools can discover entire relations sets from existing information systems and convert them to social networks formats [12]. Finally, other kind of software proposes to address the social network analysis, from the beginning, by surveying social network members about questions that can infer relations.

One of the most exciting phenomena about Web 2.0 [11] (a term used to describe a tendency to enhance creativity, information sharing, and collaboration in the web) are Social Networking Services. These websites provide ways of creating and customizing communities of people that can expose personal content in the web and can easily share it with their contacts. There are hundreds of different social networking services oriented to a more entertainment context, or to a more professional context, passing by private social networks, organizations' internal systems and niche social networks. Millions of people are present in this kind of communities and they are represented in the top of worldwide most visited web sites.

Organizations already understood the power of this concept and start to use it inside their walls by creating internal systems to support organizations' communities or by adapting existing systems to mimic common social networking services features. The integration and creation of this kind of platforms is far from being smooth and represent a challenge in various domains.

1.2. Problem

Even if several tools to build and gather social networks and perform post analysis are present in the market, the truth is that most of these tools do not present capabilities to support a continuous analysis on social networks that can evolve during time and suffer changes in structure and composition. Most of actual tools receive inputs in a defined format and do not permit that different entities modify this data in different time occasions. Gathering social networks can be a task performed by people with different background and goals, since sociologists and consultants to managers and employees and it is important to receive input from everyone. To perform survey analysis is an effective way of inquiring organizational collaborators and to receive inputs that can be fundamental to build a social network and understand how people really interact and support each other in the organization. Another option is to extract information from existing information systems that can contain interactions done by organizations' members and can be used to build social networks. Moreover, these tools can be used to analyze communities that work as interactive people directories where members can interact and share content in personal and private spaces.

However there are still no tools that can join this set of features, allowing the built of richer social networks that can be extracted from common information systems, server logs and knowledge

repositories or built by the contribution of organization's members (Figure 1). Neither is usual that these networks could be accessible in posterior phases to easily find people and content inside the network.

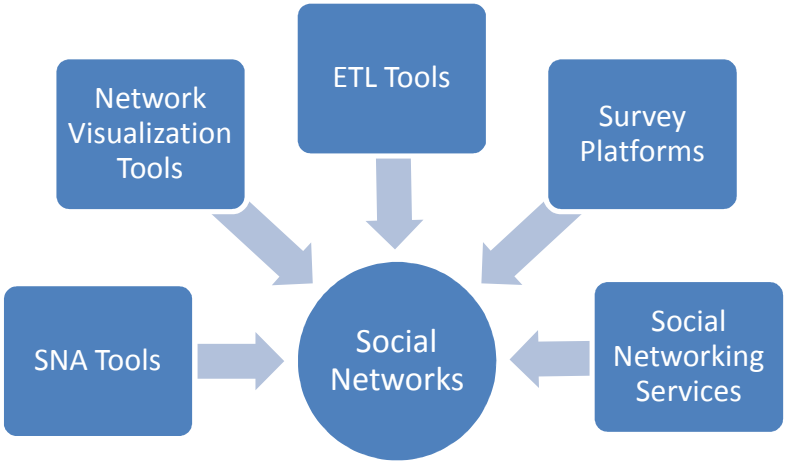

Figure 1 - Main influences of social networks in information systems

We believe that enabling all these features and capabilities in a single platform can be achieved by the development of a rich application core able of being extended to support the gathering of social networks in different contexts and sources and its posterior adaption to other goals and requirements. Furthermore we think that such a project can drive social network analysis in information systems to a more mature state able to be used in a broader set of projects.

1.3. Solution

We propose SNARE (Social Networking Analysis and Reengineering Environment) a platform to extract, instantiate and analyze social networks in different contexts. SNARE implements a social network model [16] developed to handle multiple social networks containing different entities playing different type of relations in different time occasions and that can be dynamically extended with custom properties.

SNARE is developed following Service Oriented Architecture (SOA) [17] and provides a common core able of being extended by other applications to perform gathering and analysis of social networks. This core is a code library developed in C# that uses a Microsoft Sql Server Database and is exposed by web services that are consumed by other tools. Apart from the services core, SNARE contains a java application to visualize and analyze social networks, a desktop application to extract and transform information from existing systems, and a web application that work as a front end allowing the following set of features: (1) Social Network Management, by creating social entities, relation types, relation instances and dynamic properties to enrich this kind of entities; (2) Organizational survey, by allowing members to answer to complex surveys from where relations can be extracted to build a social network, (3) Community creation, by allowing members to have personal profiles, define relations among them and

share content in private and public spaces. Web Snare is developed in ASP.Net 2.0 and is implemented in C# also.

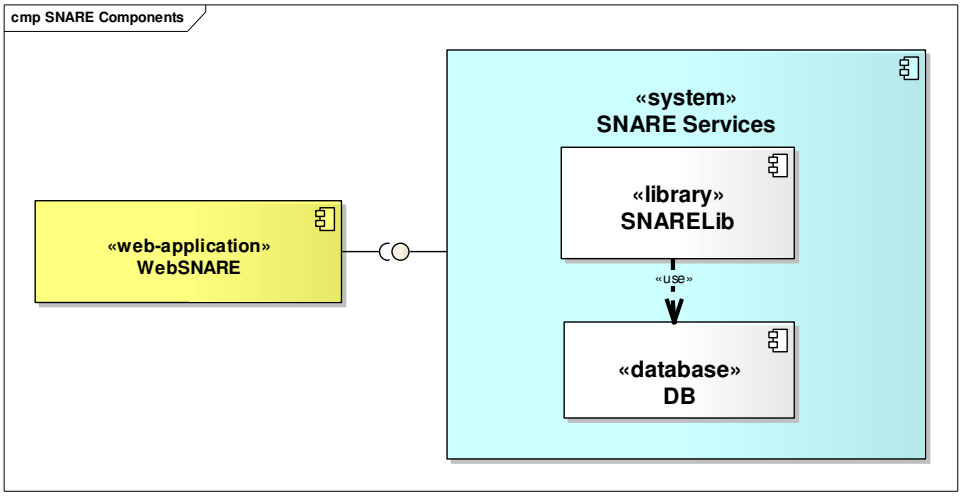

Figure 2 - SNARE components developed in this thesis

This dissertation focuses on the social network model created, as well as in the development of SNAREServices, and WebSNARE, while other research works are focused in the remaining components (Figure 2).

Research work developed during this thesis led to the publishing of a full chapter about social network tools and services in a book named "*Handbook of Research on Social Dimensions of Semantic Technologies and Web Services*".

1.4. Thesis Structure

First, in **chapter 2** are presented the key concepts of social networks, and social network analysis, explaining where its use can be useful. After the focus shifts to the use of Social Network Analysis in organizational contexts and we present a study of a set of software tools that are used to extract, visualize and analyze social networks. Lately in the section, we introduce Social Networking Services, presenting the most known examples, and some more specific systems developed to enable private communities, accessible only by employees of some organization.

In **chapter 3**, we develop the motivation that led us to work in this project, explaining how we believe that the joint of some key concepts lead to the building of a richest platform, able of being applied in various contexts and projects.

The social network model that supports all platforms is introduced in **chapter 4**, in a first glance of what we consider the key application concepts such as social networks, social entities, relation types, roles and instances, properties, and surveys.

Chapter 5 explains SNARE general architecture, high-level design, and specific components functionality and integration method. First, we deep describe SNARE core components, database design, integration processes and entity mapping to software classes. Then, we present Web SNARE, the web application developed as a front-end. We explain general structure, package composition and we describe module functionality and interactions, showing some screenshots examples. Moreover, we explain why do we use a Content Management System to implement this application and how do we successfully integrate key concepts in different modules.

SNARE was already applied in two case studies, where its use was fundamental to handle client requirements and where its joined capabilities were fundamental. In **chapter 6**, we describe Vodafone Portugal case study, where organizational survey capabilities were used to analyze a department in questions like trust, support, attitude towards change, and organization values. After, we present POSI case study, where SNARE was used to build a community of former students, allowing them to find actual information about students joined in edition groups, with personal profiles that alumni can customize, and with personal and private spaces that they can use to share content.

Finally, in **chapter 7,** we draw some conclusions about the work developed, providing some hints about future developments.

Appendix A, contains SNARE database structure, while **Appendix B** contains detailed information about Vodafone Portugal case study namely survey structure and results.

2. Background

The notion of a social network and the methods of social network analysis (SNA) have attracted considerable interest and curiosity from the social and behavioral science communities in recent decades [2]. Social Network Analysis (SNA) has been used as a powerful tool in organizations to understand the connections and influences both inside and outside the organization as well as how these connections affect the performance of core processes.

A social network is generally defined as a set(s) of actors and the relationship(s) defined among them. Actors, also defined as social entities, can be individual or collective social units that are connected by links. Links constituting a social network may be directed or undirected, but they can be categorized as confirmed or unconfirmed based on the confirmation of the relationship by both actors [1]. The relationships between actors can be also classified based on cardinality: a dyad is a linkage or relationship between two actors and a triad involves a triple of actors and associated ties.

In structural terms, there are different kinds of social networks: one-mode networks study just a single set of actors, whereas two-mode networks focus on sets of actors and one set of events. Dyadic networks and affiliation networks are examples of two-mode networks [2]. An ego-centered network is an example of a one-mode network and consists of a local actor (termed ego), a set of alters who have ties to ego, and measurements of the ties among these alters [2]. Subsets or subgroups can be identified and studied separately in the network. A clique designates a subset of a network in which the actors are more closely tied to one another than they are to other members of the network [18].

Both social actors and links may have additional attributes that express additional information about them. Such attributes include the relationship role played by the entity [19], more information about the entity, or the relationship between nodes.

The introduction of computational methods opened new opportunities for the use of social networks by allowing the analysis of larger datasets. This analysis facilitates the addition of social networks as well as their automatic extraction from existing information repositories.

Web 2.0 popularized the concept of the semantic web. Several social communities permitting users to connect and share information and knowledge with their friends or the whole community appeared.

Social Network Analysis represents a method to achieve analytical results about almost any group interactions where social entities are present. This section introduces SNA and its most common measures and explains its use in the organizational context, surveys different software tools to build and analyze social networks and finishes with the most recent social networks phenomena, the social networking services that are developing communities composed by millions of people around the globe.

2.1. Social Network Analysis

The roots of SNA techniques had three main influences beginning in 1930s. The most notable was by Jacob Moreno, who investigated how an individual's group relations affected his own actions and development. Moreno was credited of devising a sociogram as a way to depict such social relationships [20]. Most of the concepts and techniques were introduced in the 50s by work done in sociology, anthropology, mathematics, networks and graphs theory field. However if it was not always considered a theoretical field, with the arrival of computer methods the automatic analysis of large quantity of data SNA gain a new importance and has been the subject of studies and applications from the most different fields of study [21].

In the 90s, network theories emerge in virtually every traditional area of organizational scholarship as in leadership, power, turnover, job satisfaction, job performance, entrepreneurship, stakeholder relations, knowledge utilization, innovation and profit maximization [21].

Nowadays SNA starts to be used wherever a social network is present and its study can be interesting to understand and improve any group process. Recent projects applied the same methods in totally different contexts where social networks are present:

- Economy (the analysis of economic relations between countries [3])
- Health (the analysis of social networks in epidemiology studies [4, 5])
- Politics (the analysis of the political relations in a congress [22])
- Academic research (analysis the research network in a continent [6])
- Leisure and sport (the analysis of all the actions performed among all the players of a football team during a game[23])
- Organization improvement (the identification of tacit knowledge in enterprises [24])
- Marketing (the analysis of customer preferences on buying certain items [7])
- Fight against crime and terrorism [25].

Social Network Analysis is also the study focus of associations (INSNA [26], INSNAE [27]), conferences (SUNBELT [28] and journals (JOSS [29], Social Networks [30] and Redes [31]).

2.2. SNA Measures

To perform SNA is necessary to define measures that can be compared between actors or networks. Measures in SNA can be distinguished between the ones that evaluate the entire network or only a specific node [2].

In an individual level the most analyzed measure is *centrality*, which evaluates the actors' position in the network and can be interpreted as the prominence of an actor in the social group. It can be measured using: (1) *nodal degree* (number of nodes adjacent to a node, with ties from it, or to it); (2) *betweeness*

(the number of times a person lies along the shortest path between two others); (3) *closeness* (how far a person is from all others in the network). Other important concepts are *geodesic distance* (the shortest distance between a node and another in the graph) and the *structural equivalence* (the extent to which an actor shares the same set of links with another).

In a network level it is important to understand how the network is structured. *Clustering* measures the possibility of partition the graph into a finite number of sub-sets: a higher clustering coefficient indicates a bigger separation between groups in the network. *Centralization* is directly connected with the notion of central nodes: a more centralized network indicates that most of the ties are dispersed around one or a few nodes. *Path Length* is defined as the average of the distance between all pair of nodes. *Cohesion* measures the percentage of actors directly connected to each other by cohesive ties. Directly linked with this concept are the members who, if removed from a group, would disconnect the group. These kinds of nodes are called *cutpoints*. The ties that if removed disconnect parts of the graph are called *bridges.*

2.3. Organizational Network Analysis

The need of more agile, flexible, dynamic and polyvalent organizations and employees, where organizational change is a daily routine, and the raise of new ways of work, collaborate and interact has driven Social Network Analysis to a position of a "must-have" tool to analyze communities and groups. Management consultants use this methodology with their business clients and call it Organizational Network Analysis (ONA). As Rob Cross states in his book, organizations are most of the time different

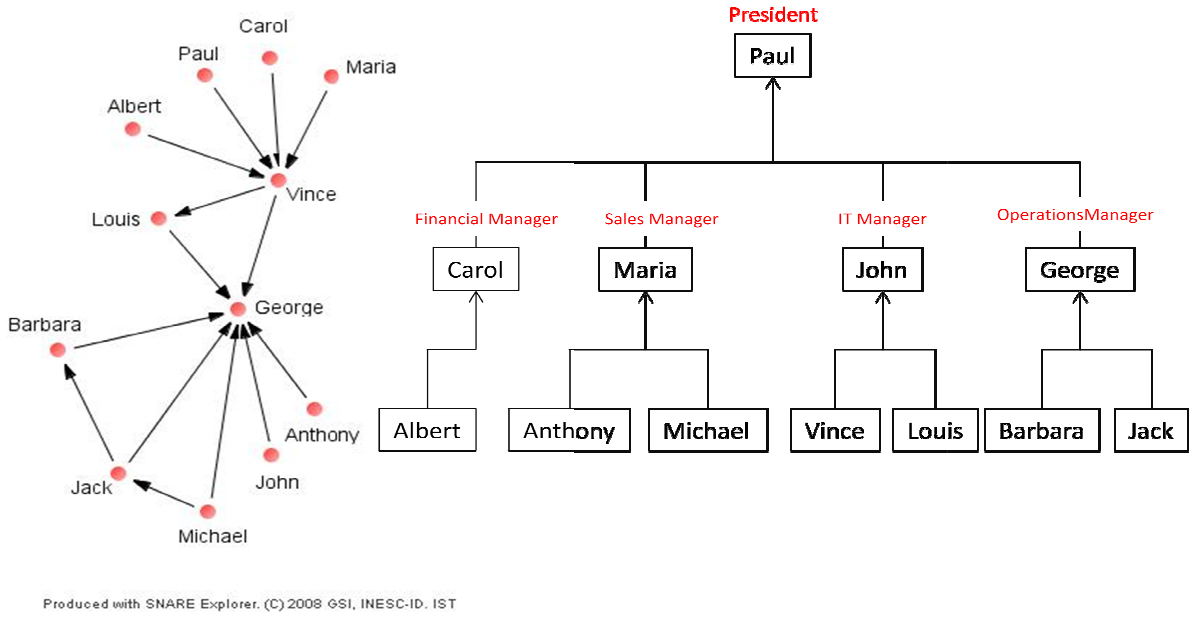

Figure 3 - Example of differences between organizational chart and real relations. Based on an example given by Rob Cross [1]

from the ones expressed in organizational charts [1]. A company's hierarchy topology is represented in Figure 3, next to the relations extracted by internal questionnaires. Looking to the sociogram, we can understand that actors in lower hierarchical positions can have a major importance inside the organization because of their knowledge, the importance of their role or the personal relations with other peers.

Factors as gender, age, ethnicity and education, can drive people to communicate mostly with peers that do not have relations with them in the organizational chart or are not connected to their organizational role. The same reasons joined with department and projects separation can conduct the company to lack of communication, lack of awareness of knowing what is present in the company, and lack of collaboration between actors. By other side the excess of importance of an actor can bottleneck all the organization. SNA can be a powerful managerial tool because it makes visible the pattern of relationships within and across strategically important networks [1].

Social network analysis can be used in an organization to better understand the social capital (the connections within and between the network) [21], to support partnerships and alliances [1], to measure the degree of embeddedness of the actors and understand their importance in the network, to support knowledge management policy, knowing who really knows what in the company [31], to integrate networks across core processes, to promote innovation, integration of new members or organizational changes, to support the development of informal communities of practice, to improve leadership effectiveness and replicate high performance throughout an organization, and to understand and improve the disconnects between groups in the organization or connections to the outside world [1].

2.4. Tools and Services

There are several software packages available to support Social Networks Communities or perform SNA. The packages can range from complete software to analyze, and visualize social networks to systems that permit to design and execute surveys and using the data received to perform a full network analysis. There are also systems that allow to automatically discovering network information by mining a data repository or a communications gateway. As depictured in Figure 4, this section surveys approaches and

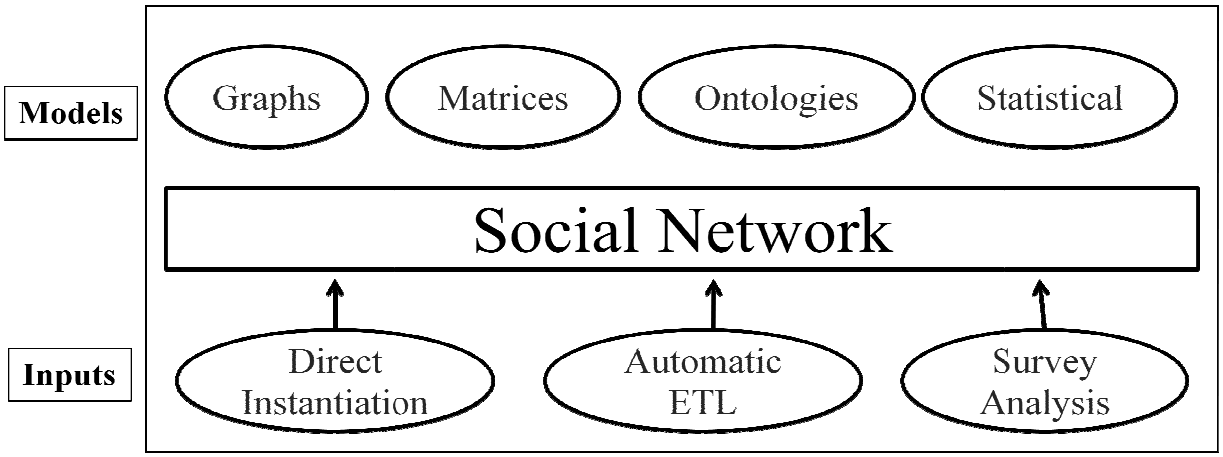

Figure 4 - Different approaches to capture and represent a social network.

formats to represent Social Networks, as well as tools and services to support Social Network Analysis.

2.4.1. Representations

Most common forms of representing and analyzing social networks are through (1) descriptive methods (e.g. text or graphs); (2) analysis procedures often based on matrices operations presented in data files with proper formats or ontologic representations; (3) statistical models based on probability distributions. One reason for using mathematical and graphical techniques in SNA is to represent the descriptions of networks compactly and systematically [18].

Graphs. Graph theory provides a vocabulary that can be used to label social structural properties: points called nodes are used to represent actors and lines or arrows connecting the points are used to represent the links. A graph is called directed when its edges have a direction, or undirected if not. Visual representation of graph can be used to center in the screen the most connected actors in the network, to isolate in the periphery the less connected, to alter the actors and ties size in order to represent more or less importance in the network and can be a powerful tool to uncover patterns in the network [1].

Matrices. Matrices contain the same information as graphs but are more suitable to calculation of measures in analysis. The adjacency list is the primary matrix used in SNA and is usually referred as sociomatrix. Actors occupy first line and first column of a matrix composed by as many rows and columns as there are actors in the data set and the cells have a positive value where the relations are present.

Ontologies. Conceiving ontologies (explicit specifications of the conceptualization of a domain) as engineering artifacts permits to objectify them, separate them from their original social context of creation, transfer them across the domain [32] and export data to other sources. GraphML [33] is a language to model graphs that can be adapted to represent social networks, FOAF [34] is a machine-readable ontology describing persons, their activities and their relations to other people and objects, hCard[35] is a format for publishing contact details of people, companies, organizations, and places that start to be used as a format to import and export data in social networking websites. DyNetML is a universal data interchange format to enable exchange of rich social network data and improve compatibility of analysis and visualization tools [36, 37].

Statistical Models. Statistics models enthusiasts argued that it is most fruitful to consider models where network evolution is represented as the result of many (usually not observed) small changes occurring between the consecutively observed networks, made at discrete time [38]. That kind of models describe the evolution of local structure, global connectivity, search ability, and highly skewed degree distributions as mathematical formulas that can be predicted and analyzed. Recently, there has been a growing interest in exponential random graph models (ERGMs) [39] that describe a general probability distribution of graphs on *n* nodes and consider the possible ties among nodes of a network as random variables.

2.4.2. Social Networks Tools

The common way to extract a social network is by instantiating it directly through SNA software packages. However, it is also possible to automatically extract Social Networks from information gateways, or through automatic survey analysis. In Figure 5, are represented the most important tools organized by main scope of application. Most of the software packages analyzed share common features to extract analyze and visualize social networks.

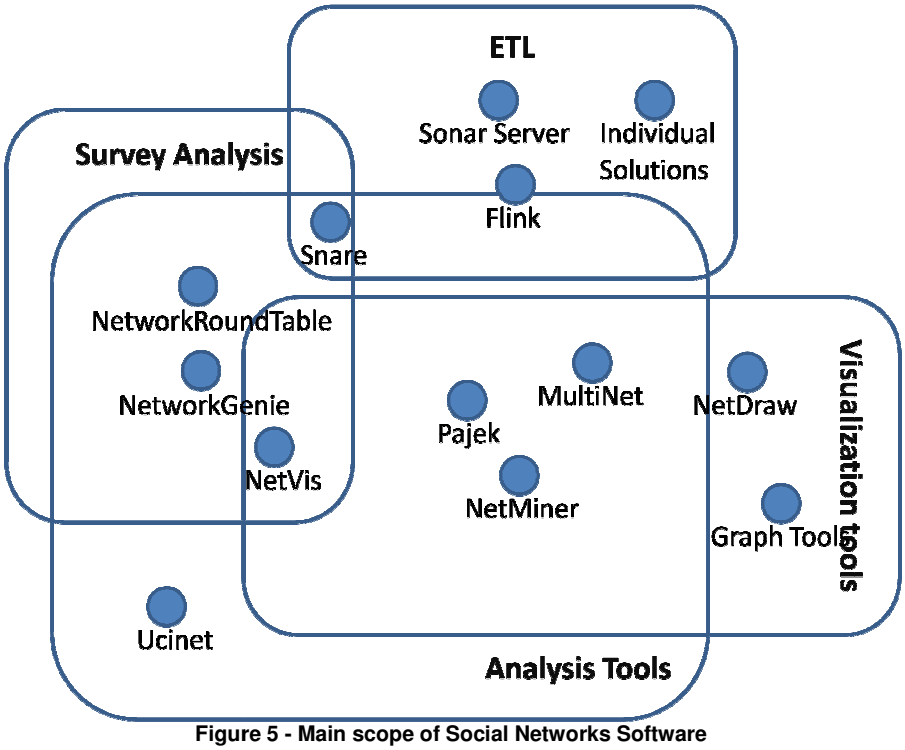

Figure 5 - Main scope of Social Networks Software

2.4.3. Visualization and Analysis Software

Ucinet[9] is probably the best-known and most frequently used software package for the analysis of social network data [2]. It is a commercial product developed by Steve Borgatti's team but an evaluation version is available for 30 days. Ucinet uses datasets as collections of matrices, can import data in various formats but has also a spreadsheet editor to permit data manipulation. Ucinet works as a graphical application and is distributed with a user manual and a reference guide for social network analysis. Contains a large number of network analysis methods such as analysis procedures for compute centrality degree, ego network analysis, detection of subgroups and structural holes in all the network or part of it. Includes also statistical procedures and can handle two-mode networks transformations and analysis. Ucinet does not contain graphic procedures, neither visualization techniques but can export directly to NetDraw (developed by the same team), included in its own package, or other formats.

Pajek is a free software developed by University of Ljubljana and is specially designed to handle large data sets [8]. It is distributed with a reference manual containing a list of commands and operations but

there is also a textbook about SNA theory, applications and the use of Pajek to perform a network analysis [40]. Data can be entered directly into the program, by importing ASCII network data from network files, by importing data with other formats (UCINET for example), or by opening a pajek project file (.paj) which combines all the data structures supported in one file. Pajek permits the manipulation of all its structures, for example transpose of networks, directionality change in graphs, or network extracting. Advanced visualization techniques are present in Pajek: the network drawing is based on the principle that distances between nodes should reveal the structural pattern of the network and Pajek uses spring-embedding algorithms, who seek a configuration of the bodies with locally minimal energy, that is, a position for each body, such that the sum of the forces on each body is zero [41]. Algorithms as Kamada-Kawai [42] and the Freuchterman-Reingold [43] are good examples of this kind of technique. Graph images can be exported to traditional image formats. In Pajek descriptive methods are also present: computation of degrees, depths, cores, centrality (closeness, betweeness), detection of components, paths, structural holes and some binary operations on two mode networks [38]. Unlike Ucinet, Pajek has no direct procedures for detecting cliques, because it is hard to do that on large networks. However, it has the p-cliques procedure, that results in a partition of the network nodes into clusters such that the nodes within one cluster have at least a proportion of p neighbors inside the cluster. Some statistical procedures are also available and Pajek can invoke directly statistics software.

Netminer is a commercial product developed by Cyram and contains analysis and visualization techniques [44]. NetMiner has an innovative data model composed by a dataset of various unit data, designed to represent almost every feature of network data. NetMiner has the easiest and simplest user interface of all this category of software and almost all results are presented both textually and graphically. Constructing new dataset out of nodes and links on visualized network map for subgroup analysis can be easily achieved just by mouse-dragging on network map without time-consuming main menu navigation. Network-drawing can be based on spring-embedding algorithms, multidimensional scaling, analysis procedures (e.g. centrality) and simple procedures (circle, random). Built-in standard statistical procedures and charts are also integrated in NetMiner.

2.4.4. Survey Analysis Platforms

The problem present in the category of software introduced in last section is that it obliges the analyst to insert data gathered from other ways (interviews, surveys, observation) into specific formats. Other kinds of tools start to appear and propose to accomplish SNA since the beginning, including the initial surveys to infer relations in the network.

Netvis is a web-based tool, distributed as open-source to analyze and visualize social networks using data from comma separated value file (.csv) but also from surveys [10]. The software permits that someone registers the actors present in the network, define a survey and use the data received from the answers of these survey to perform a social network analysis. Although the software itself has the

standard procedures to analyze and visualize networks, it can also export data to the most common formats.

The team of University of Virginia's McIntire School of Commerce headed by Research Director Rob Cross developed an application called Network Round Table [1, 13]. Most of the content and the documentation is not public and is only available to clients who subscribe paying an annual fee; however its features, steps and procedures are available on the website. Based on an organizational perspective, the software permits that an analyst register or imports all the enterprise actors into the system, join them into teams or groups and assign them roles. After that, the analyst can create a survey with questions to infer all the social relations in the network and their strength or frequency. The software is powerful enough to direct only specific questions and answers to specific actors or groups and questions can be open, rating scale type, multiple-choice , order importance choice, can be nested in groups and the analyst can explain how each question is important and what he wants to infer from the analysis of the answers. After the survey activation the users registered receive an email informing that they should visit a web address and properly fill the survey. The analyst can check the status of the survey, and when he gets a satisfactory result of answers he can close it. After closing the survey, an individual action plan is available to all actors with the analysis of their own answers, and the analyst can view and analyze the results of the complete network. There are available options to export the data to the most common formats but simple direct analyses are also present in the software. The analyst can also view, edit, annotate or delete individual answers and filter them by parameters. The team states that the personal network feedback enables by itself each actor to assess his connectivity within the network and to think and improve it by planning changes. The feedback is delivered on paper that can be analyzed in group meetings or in an online action plan, that the actor can annotate and plan actions to increase connectivity.

Network genie is an online application developed by Tanglewood Research, for designing and manage social network projects, including the design of surveys and survey questions, the management of social network projects, the collection of social network survey data, and the import/export of data to SNA software [14].

The main concept of this kind of software is to gather information from surveys and to automatically export them to most common software for SNA.

2.4.5. Platforms to Social Networks Extraction, Transformation and Load

More recently, the use of electronic data extraction became popular in the study of social networks. While traditional survey or interview methods are limited in the size of networks and the number of measurements (time-points), gathering electronic data enables large scale, longitudinal studies of networks [45]. Automatic detection of relations is possible from various sources of information such as e-mail archives, schedule data, and web citation information [46]. What this kind of systems proposes is to

gather information from a large collection of data and tries to identify and disambiguate social entities and understand the links between them and also their strength, periodicity or probability.

The SONAR platform [15] developed by Trampoline Systems, proposes to plug into the corporate network and connects to existing systems such as email servers, contact databases and document archives to extract and analyze data to build a map of social networks, information flows, expertise and individuals' interests throughout the enterprise [47]. The platform consists of several functional modules which can be combined as required by each customer and all the information is available to managers and personal data to users.

Flink, the best semantic web application at the semantic Web Challenge of 2004 in ISWC2004 and developed by Peter Mika's team supports the complete process of data collection, storage and visualization of social networks based on heterogeneous sources of electronic data [45]. Data comprising social networks tend to be heterogeneous, multirelational and semi-structured [12]. Link mining is an emergent field of research with contributes from many areas that can help social network mining. Can be used to classify entities based on their links, predict the type or even the existence of links and their evolution and detect subgroups and properties common to some group [12]. Polyphonet [46] is a social network mining system that has been used at four academic conferences in Japan to infer the relations between authors, reviewers and participants. It is a good example of the use of link mining as it uses web search engines to understand and measure the connections between persons, using a balanced coefficient to define relations.

2.4.6. Social Networking Services

Even if from its start the web is itself an example of a social network and the formation of communities is one of its most important achievements, the Web 2.0 [11] boom brought the concept of group sharing information possible to a big part of users with the spread of wikis, forums, blogs and social networking communities (Figure 6).

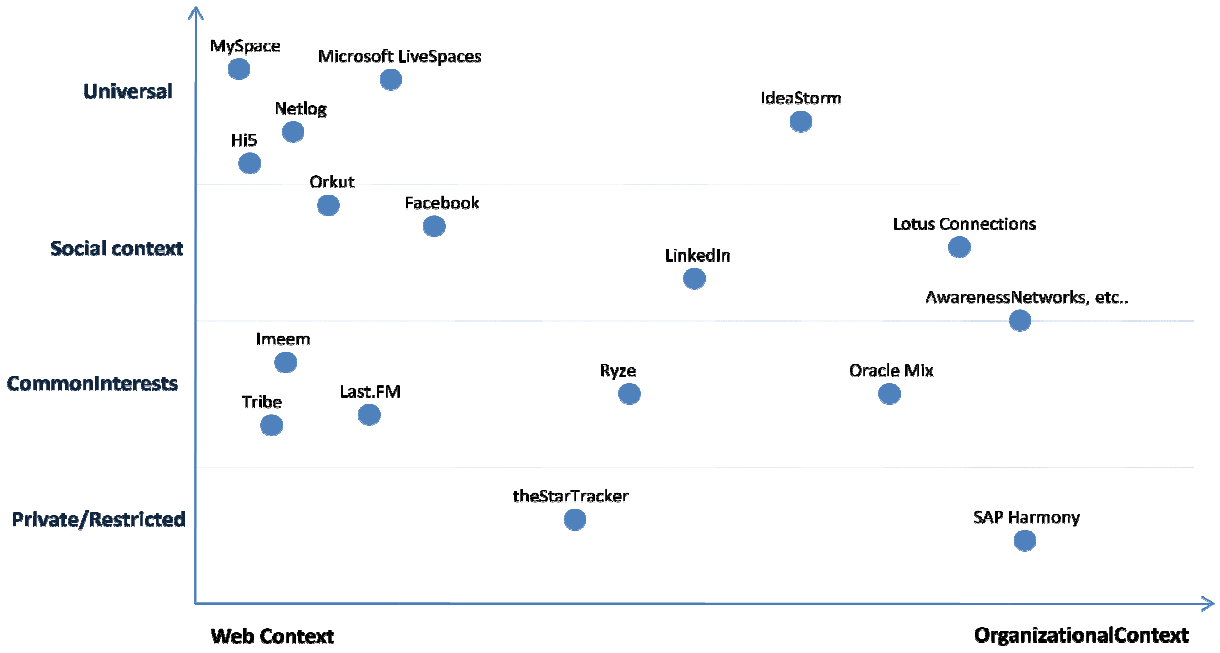

Figure 6 - Social Networking Services scope

Although these websites feature much of the same content that appears on personal Web pages, they provide a central point of access and bring structure in the process of personal information sharing and online socialization [18].

Basically in these websites people can register, or be invited and after upload information about them self, upload photos, join groups of people and connect to other persons being their friends, or sharing the same interests. People get organized in networks or groups and can see each other's profiles, relations and actions in the network. Also in most of the websites people can upload and tag photos, share files, post in blogs and interact in other ways with their peers.

2.4.7. Community-wide Services

According to web statistics website HitWise.com [48], Myspace [49] is still the dominant social networking service with more than 200 million of users registered and according to Alexa [50] is the sixth most popular website in the world. Founded in 1999, MySpace offers to the users features like profile customization, comments, ability to post videos and music and participate in groups and bulletins. Apart from that MySpace innovated, offering the users an instant message service, a classified ads system, news and a video sharing system.

Founded in February 2004, Facebook.com started to be open only to college students but today has more than 70 million active users and 55,000 networks. The website permits that someone registers and join his university, work or village network, upload information and photos, tag persons, organize and join events in the network and exchange messages and other content with his friend's network. Facebook's

Platform API enables anyone, to build complete applications that users can join and use on their profiles and friends' network opening new opportunities for development of new concepts using social network and currently 12000 applications have been built on Facebook platform. Other facts about Facebook are impressive: the active users are doubling every 6 months and, more than half of active users return daily and people spend an average of 20 minutes on the site daily.

Friendster.com [51] with almost 50 millions of registered users is a very important website in Asia and has recently developed a public API as Facebook that permits the growth of the community. Especially in Europe, Netlog.com [52] has a big importance with more than 32 millions of users registered along with Hi5.com with 50 million of users registered.

	Users (Millions)	Notes
Myspace	200	Oldest and most famous SNS. Sixth most visited website in the world.
Facebook	70	Has the biggest current grow. Doubling the number of users every six months.
Friendster	50	Specially used in Asia.
Hi5	50	Most visited website in Portugal in 2007.
Netlog	32	Specially used in Europe.

Table 1 - Most popular social networking services

Big enterprises are also already in this market: Microsoft have Live Spaces [53], Google have Orkut.com [54], and Yahoo has Yahoo 360º [55].

There are also specific networks more oriented to persons with same interests (Tribe.net [56], iMeem [57], Last.fm [58]), to persons who want to find old friends (classmates.com [59], graduates.com [60]), who wants to share photos with friends (Flickr.com [61]) or for example for people who wants to join in charity projects (SixDegree.org [62]).

According to Hitwise.com, 6.5 percent of all Internet traffic in February 2007 in all the world was generated by this kind of social networking websites and according to Nielsen/NetRatings, another web statistics website, social networking sites are the reality television of the Internet. In Portugal the most used social networking website is Hi5, being also the most visited website in Portugal in 2007, according to Alexa. Table 1 shows statistics and curiosities for biggest social networking services.

Even if few social networks currently charge money for membership, the fact that this kind of communities are constantly renewed by their members, organized in networks by interests, localization, or situation means that these websites can sell specific ads to specific groups what is really appellative for investors and can extend even more in the future, the context of these communities. There is also a tendency to define a standard way to exchange data between these services. Google OpenSocial [63] provides a

common set of APIs for social applications across multiple websites and is supported by some social networking websites. It is composed by three APIs that permit that programmers can access to core functions and social networks information: profiles, friends' information and activities.

Although, other questions are being brought by the success of these communities, concerns about users giving out too much personal information that leads to lack of privacy, concerns about the fake content and profiles presented on them start to appear. Information posted on sites such as MySpace, Hi5 and Facebook, has been used for example by the police to prosecute users.

Social networking services can be also used in a more oriented professional context. LinkedIn [64] is a website where people can post their professional experience, share and connect with others with the same interests or professional background, or even same company. Ryze [65] is designed to link business professionals, particularly new entrepreneurs. The site claims to have over 250,000 members in 200 countries, with over 1,000 external organizations hosting sub-networks on the site. Portuguese website theStarTracker [66] allow its members to join into communities of Portuguese people working abroad and understand what they are doing.

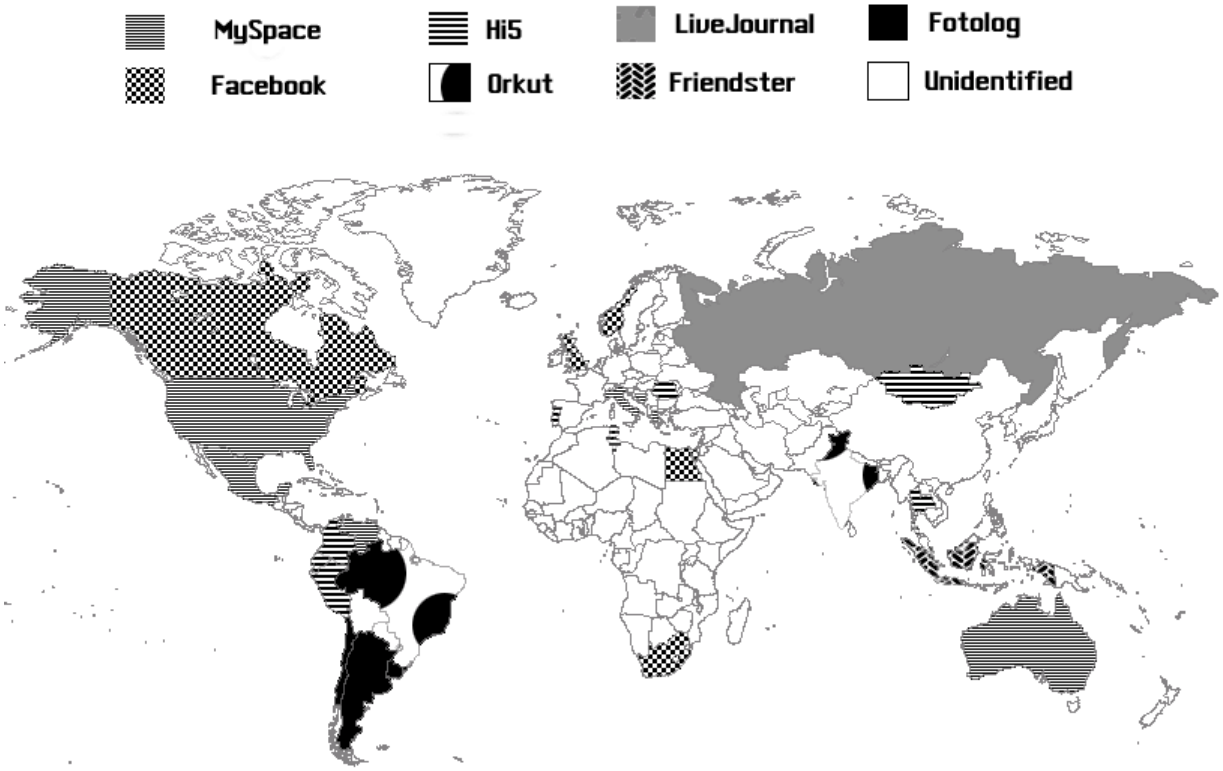

Figure 7 - The world map of social networks (Adapted from Valleywag)

It is not easy to explain why different services have different popularity in different countries and cultures but the truth is that each service is mainly used by some kind of communities or cultures. ValleyWag

published in 2007 a world map of social networks according to their use in different countries (Figure 7). Even if MySpace is still the global leader different websites win the contest of more popular SNS in different regions.

2.4.8. Organization-wide Services

Big companies start to understand the power behind this kind of systems to share knowledge, experience and practices inside and outside the company. In November 2007 a team in Oracle launched Oracle Mix [67] a social network to oracle developers, partners, employees and customers to share best practices, experiences and ideas together. Dell also developed a similar system called IdeaStorm[68] that is used to customers share ideas with the company and get the feedback of the community, Sap developed an internal system called Harmony and is already being used by SAP Labs users behind the firewall. IBM went further introducing in the market, in July 2007, Lotus Connections Suite [69], a software suite that permits company's employees and partners to register profiles, and share ideas, experiences, activities and resources about what they are doing in the company or with the company products and create new communities. IBM itself uses this suite inside the company working as the company yellow pages. Even SharePoint 2007 [70], a collaboration suite from Microsoft, already has some business social networking capabilities like user profiles, people search facilities, tools like wiki's and blogs and is expected to be expanded by social networking driver. Other firms like AwarenessNetworks [71] and HiveLive [72] are also developing this kind of social networking applications for enterprises.

3. Problem and Proposal

This section addresses the major challenges present in this research area, explaining the major problems identified in actual platforms and depicting what can be considered as requirements that a social network platform must follow and which goals it proposes to achieve.

3.1. Problem

Nowadays a number of tools to perform social network analysis are available in the market to help experts to understand social networks. These tools are built to perform single time analysis, applying common social networks analysis algorithms and representations. However this type of tools does not perform real time or continuous analysis.

To discover how an organization social network is structured is not easy, especially if we are talking about organizations with hundred of entities. It is important to map the real network, i.e.: the joint of all personal connections among all members. It is hard for an analyst or sociologist to understand all the real connections between actors inside organizations, therefore is important to save actors' personal input and use it to create the network. Doing this by traditional means involves receive the input from actors and insert it in social network analysis applications what can also be a slow process propitious to errors.

To connect SNA tools to information sources as application logs and enterprise applications is hard and it is done, most of the times, by converting data in specific times by customized conversion processes. Such extraction processes cannot be adapted to other situations or platforms, representing a vertical process.

Collaborative applications are common in organizations to enable knowledge sharing between organizational actors and work as a repository of what is known inside the enterprise. Losing knowledge when employees leave the organization, change organizational role, or simply forget past work represents a dangerous threat to productivity and efficiency that should be seriously taken in account by directors. These applications can have embedded other features as people directory or business processes workflow applications, but rarely presents any SNA feature. It is important to understand that real social networks are built on this kind of platforms, with interactions among social entities so its analysis can be helpful to understand organizations.

With Web 2.0 boom people start to use Social Networking Services as a type of collaborative applications, interacting with known contacts and discovering new people that they find interesting or with they want to contact. Social Networking Services adapted to be used in an organizational context can be used as people directory, knowledge repository, and increase connectivity, productivity and information sharing inside organization. Social Networking Services used inside organizations are interesting case

studies to be analyzed in a SNA perspective, however they do not have SNA features and there integration with SNA software is not easy.

3.2. Proposal

In order to solve the problems depicted in last section we propose SNARE (Social Networking Analysis and Reengineering Environment) a common platform to represent, promote and analyze social networks in organizational contexts (Figure 8). SNARE joins in a single platform, capabilities to create social networks adapted to organization's context, allowing members to create communities and surveying organization about crucial questions.

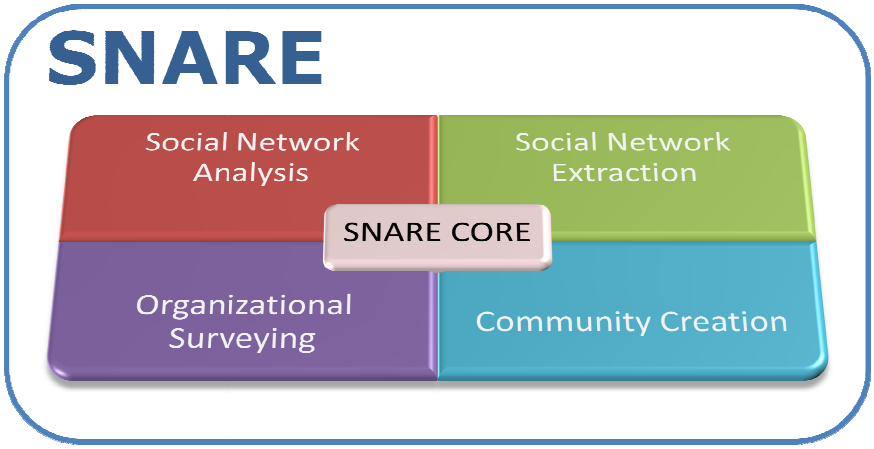

Figure 8 - SNARE joint capabilities

3.3. Goals

SNARE should be able to represent any social network present in different contexts as organizations, groups, enterprises, teams and communities so it is expectable to model any domain where exists any interaction among one or more entities, playing different roles.

SNARE should join capabilities of Social Networking Services adapted to organizational contexts with techniques from Social Network Analysis in order to improve information sharing and awareness inside organization walls. In big organizations this kind of platform can work as an active knowledge directory and can enable workers to easier find expertise and know each other better. Moreover, we want to enable organizations' managers or external consultants to extract physical or virtual social networks from daily life organizations' processes or information systems used by the workers to communicate. All the SNA goals and benefits described in chapter 2 are applicable in the project and represent fundamental features that should be present.

Sociologists or organizational engineering experts can directly insert different social entities, relations and roles into the system that they understand as part of organization's daily life. However, more direct ways

should be present and social network capture by survey analysis should be possible, allowing the social entities to contribute with their opinion and awareness to the organization's social network created in the daily life that could be different from the one managers think that exist, or the one that could be expressed based in organizational chart [1].

Finally, SNARE can be used to handle social networks present in other information systems. Such kind of systems can be online communities, bulletin boards, other social networking services or even organizational workflow applications and phone and email logs. Applications extensions can be developed to directly communicate with SNARE or by other side the platform can import data to be converted to its own social network model.

3.4. Requirements

In order to successfully achieve all the presented goals it is important to restrict the ambit of the project by approaching every user needs, and to divide functionalities and capabilities by actors and scopes.

3.4.1. Actors Hierarchy

SNARE should be accessible by different entities using a login and password and should handle several social networks in the same software instance. Members and managers of a specific network can only access their network information but a general administrator should be allowed to manage all networks. Several system options, tasks and views should be present to different actors. Social entities can accumulate different roles linked with social networks: an actor can be a member of some network and as the same time can be a manager of another network. SNARE Actor hierarchy is represented in Figure 9.

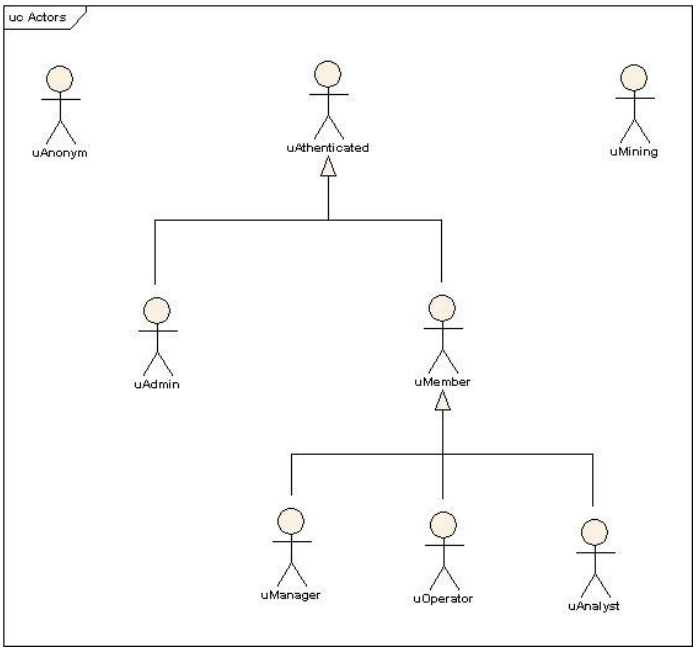

Figure 9 - Actors hierarchy

uAnonym – It represents anyone who can register into the system or browse public information about the project or the public networks inside it.

uAuthenticated – This actor represents any user authenticated in the system, but that could be not yet a network member, he can just be not associated with any network so he can create a new one or join an existing open network.

uAdmin– The administrator actor is able to manage SNARE application structure and modules behaviours and privacy, to manage all networks options and members. The administrator can redefine each entity login, and system roles and its association with different networks. Administrators can create and remove social networks, and edit current ones.

uMember – A network member represents any authenticated member that belongs to one or more networks. He can search for other social entities in the network by some known property, can connect to other people and define relations with them, can answer to network surveys and customize personal data and his profile.

uManager – A network manager is able to manage social entities in his network, to customize social network options, to define type of relations and to define and administrate surveys.

uOperator – This actor is able to instantiate relations between social entities and can represent someone with abilities to instantiate a social network by its observation or prior knowledge. He can also edit all the relation instances present in the network.

uAnalyst– An analyst is someone with SNA knowledge and experience and is able to use SNARE to perform social network analysis and infer some conclusions from the data that he achieves. It can be typically considered as someone from outside the organization hired to analyze results and to propose reorganizations and changes in the network.

uMining – A mining actor can represent some software plugged into other systems and platforms in order to extract social entities and relations and connect to SNARE to transform and load this information into the system.

3.4.2. Requirements by scope

We can divide requirements in the four functional areas covered by SNARE grouping capabilities and use cases.

Social Network Analysis

To perform social network analysis in the network is necessary to implement common social network analysis procedures and methods to analyze common measures defined in section 2. It is important to depict analysis on specific actors, relations or properties, to transform data to produce clearer results and

more important it is important to save analysis data so it can be compared later with other analysis or to conduct changes in the network based in data analysis. It should be possible to analyze all the network or only small groups, selected or joined by common properties. It is also important to analyze the network in specific times and compare it with other time occasions: this allows the manager to compare different properties before and after some restructuration, fusion, or role change between actors.

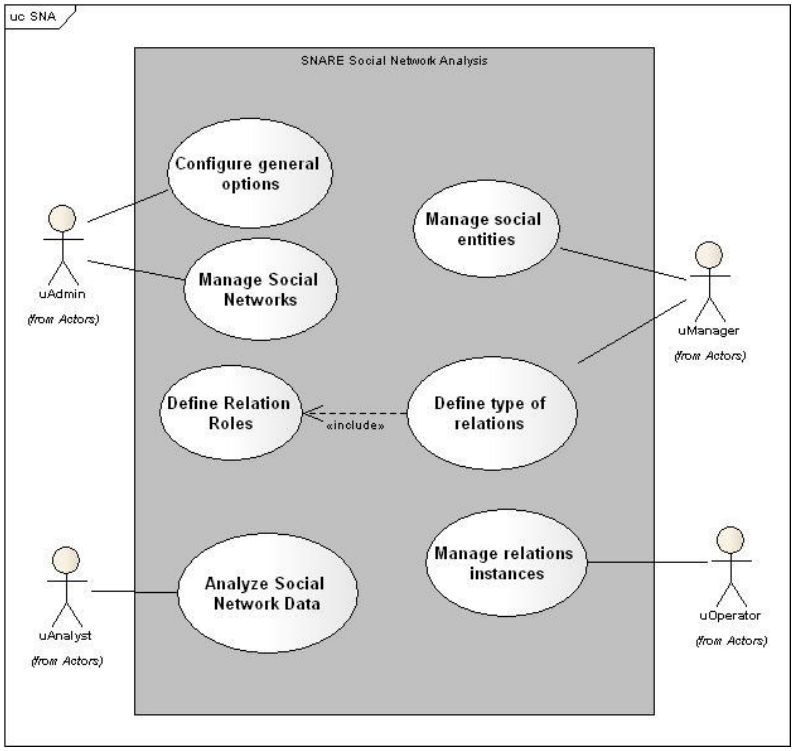

Figure 10 - SNARE social network analysis capabilities

Organizational Survey

Conducting surveys is an easy way to discover relations and to build a social network based on answers given. Different questions can be set in order to discover specific data about entities in the system. Questions can have close or open answers, and can have already some defined options or allow the users to choose different answers. Going further it is even possible to infer relations and properties, and map them directly into the social network model, building and enriching a social network. Managers should have total control in the definition and administration of the survey. Individual and group real time statistics should be available in order to help managers to access all the information they want to infer before any conclusion be drawn and drill down to individual points of view.

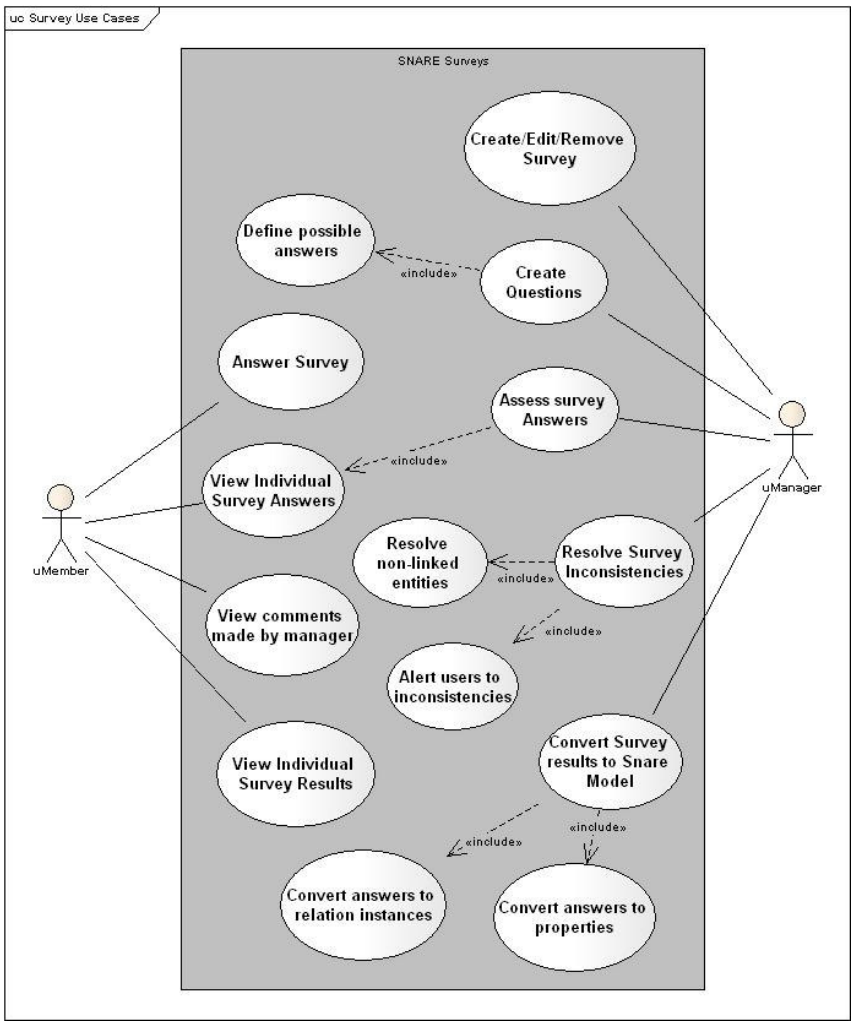

Figure 11 - SNARE organizational survey capabilities

Community Creation

Social Networking Services represent a new way to connect people and share content and knowledge between a set of social entities connected with each other. The system should present some features common in this kind of platforms, namely the ability to customize personal data and to define relationships between entities. Every social network member should have a username and a password to login in the system and access his private area. It should be possible to create and join groups of interest that can represent informal or defined groups or communities of practice inside organizations. It is very important the easiness of searching among all entities by some particular characteristic or information. People should find any entity in the system, and see her connections finding new entities by similarity or known connections. Communication networks inside the organization represent opportunities to people find new entities that they can know and can be helpful in different contexts. Awareness of what is happening in the organization and who is present can enable more cohesive networks and productive organizations. This kind of systems should represent a productivity increase, instead of representing new

ways of distracting employees of their main tasks and adapt to an organization's characteristics and workflow processes to provide increased value to employees and departments instead of creating unnecessary entropy inside an organization's walls. Employees should recognize a system's value before they begin using that system. Important organization information should be present even without the contribution of organizational actors. However, their contribution is fundamental for success, so different modules should be present in order to promote strong connections among actors. These modules could include bulletin boards, profile pages, groups and communities of practice, messaging, the ability to find people based on their interests, departments, or related work, easy content sharing using wikis or blogs, and other popular Web 2.0 tools.

Privacy should be a major concern: people should be able to define who can see particular information and who can edit defined content. Organization managers should be able to tag entities with some properties that should not be visible or changeable by each social entity, however can define or let the members define some particular characteristics that they want to share with the network. Managers should have full control of what is present in the network and should be able to map existing organization entities and relations in the platform, while members should be able to edit and customize own editable data.

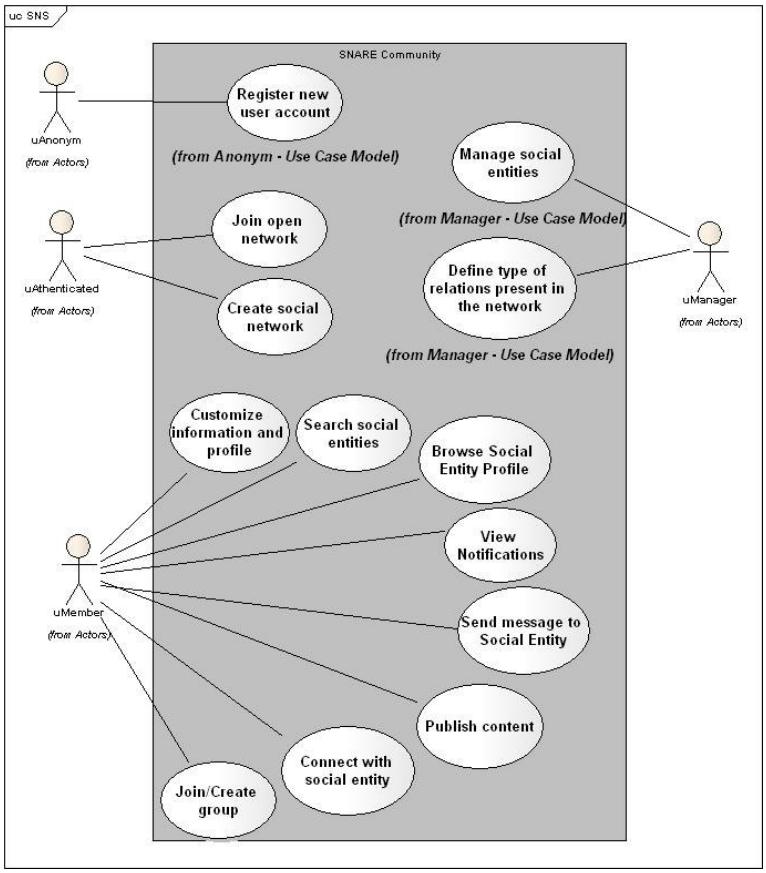

Figure 12 - SNARE community creation capabilities

4. Social Network Model

A social network model is developed to map social networks in different contexts and situations, with variable dimensions and structure and coming from a plenty of sources.

Important concepts included in the model are (1) social networks, (2) social entities,(3) relations and roles, and (4) properties. A social network as stated by literature is a set of social entities related by relationships. In a relation every social entity plays a role, and these relation instances are characterized by defined time duration, context and domain. All these entities can be characterized using additional dynamic properties that extend the basic information. Figure 13 represent main domain entities.

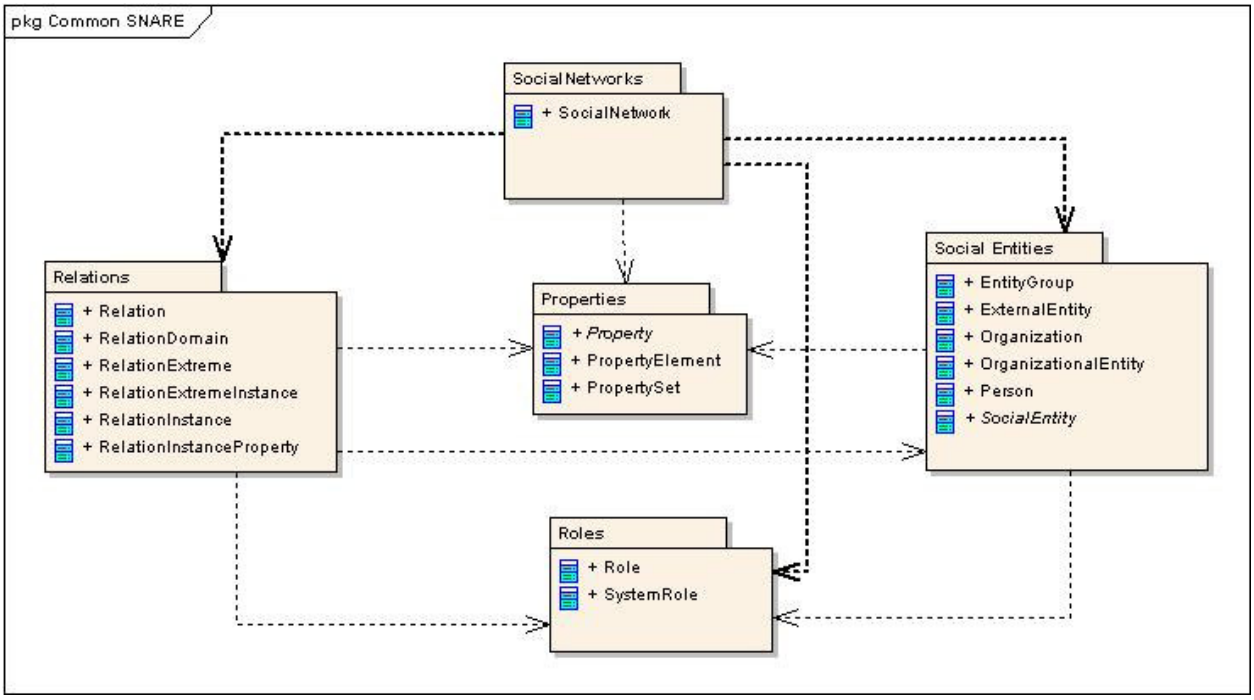

Figure 13 - Social Network Core Concepts

4.1. Social Network

Social networks are basically constituted by social entities (actors) and relations (links) among them. The relations between these entities are represented in Figure 14.

Each social network represents for instance an organization, a team, a group or department and is associated with social entities, contexts and type of relations. Social Network contexts try to model situations where certain relations can happen (during a course, an exam, a project in an academic social network for instance, or during a meeting, a project, a business lunch in a enterprise network). Contexts represent a way of grouping relations by situations and permit to identify which relations occurring during a specified business process, during certain project execution or by causality or proximity. System roles

are played by social entities and define the responsibility that each social entity has in the network management i.e. a specific function as network manager or network analyst. Every social network must have a defined owner that represents the social entity responsible for it.

Social networks have defined relation types that can be played by social entities. The relation types depend on the network type: in an academic organization it is expect to find relations as teaching, group working, classmate friendship, former classmates knowing, tutoring. Social networks have an associated set of social entities that represent persons, groups and other entities that have significant interactions to be analyzed. SNARE social network model permits to enrich social networks, relations, and social entities with properties that can be shared between social entities or relation instances. Each social entity can have different system roles in the same social network and can belong to many social networks.

Relations, social entities, property sets and properties can be shared between social networks. A structural field *isTemplate*define if this kind of entities is able to be copied to new social networks.

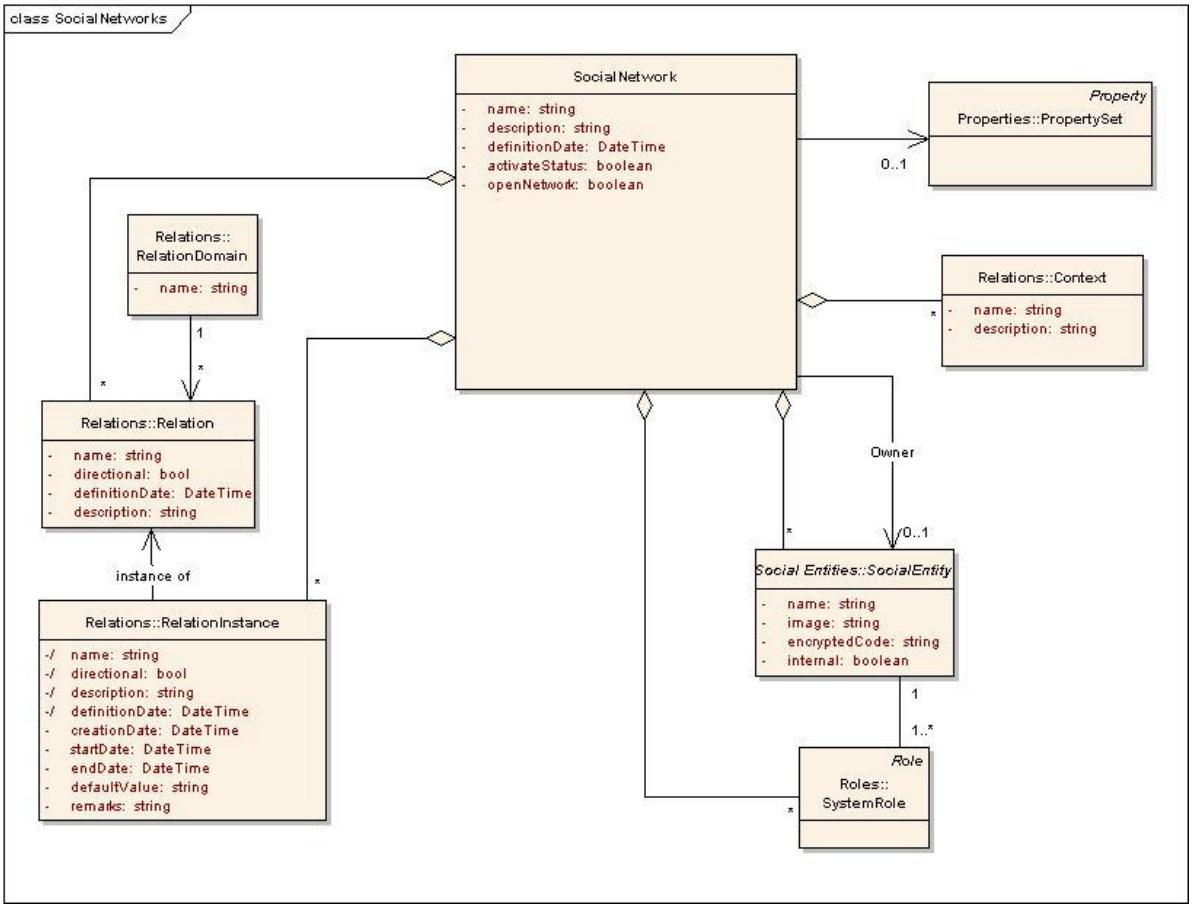

Figure 14 - Social Networks Domain Model

4.2. Social Entities

A social entity represents any entity that can have interactions with others in social networks. The most basic and obvious social entities are persons but they can be joined in groups called entity groups and the group itself is a social entity. Entity groups can be used to model teams, departments or communities of practice inside an organization. External entities try to model all the entities that do not belong to a social network but have interactions with internal social entities. Consultancy firms or employees, World Wide Web bulletin boards and Wikis are good examples of external entities with social entities interactions that are important to represent. External entities have the ability of be promoted to other entities: an external employee of another organization that audits the target organization can be modelled as an external entity but if for instance got hired, he can be promoted to a person and become a normal employee. Social entities composition is shown in Figure 15.

Organizational entities represent all the other important entities in the organization that are not persons neither groups of persons. Internal information services, mail servers, knowledge repositories, business processes are examples of non-human entities that can be modelled as organizational entities.

Organizations can be also considered social entities: they can belong to their own social network having the owner system role or they can be inserted in other networks and have relationships with other organizations or social entities.

Each social entity apart from having their structural properties as name, image, email, etc can have a set of particular properties with more information: persons can have details as salary, position, hired date, annual evaluation, and main function in the organization, work developed, expertise areas or interests; groups can have the usual meeting room, conditions to be accepted, etc. Social entities have a property set that have a defined group of properties. The same property set can belong to one or more social entities, depending on the fact that all the entities have the same type of properties or not. Properties can also belong to one or more property set and their instance value is associated with a social entity.

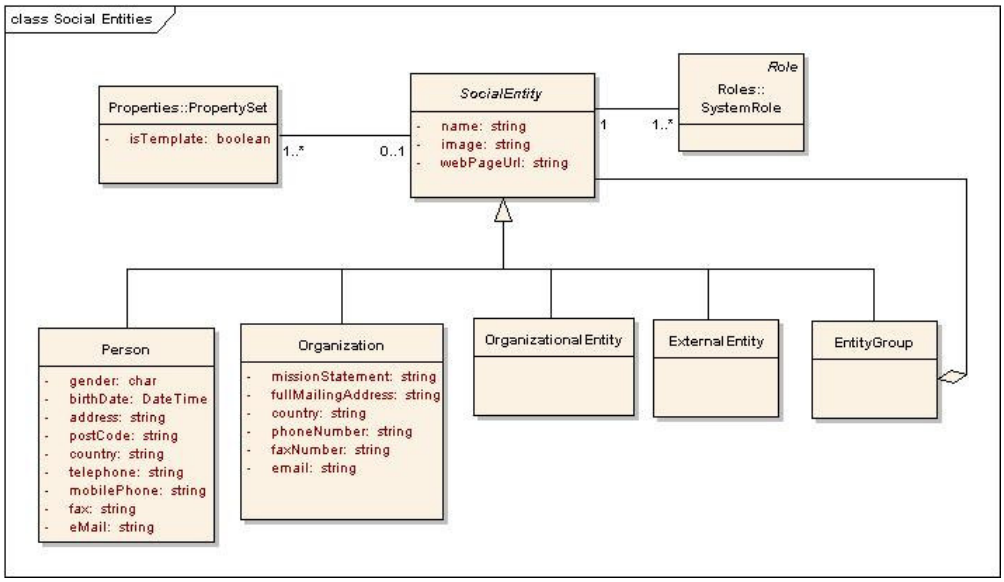

Figure 15 - Social Entities Domain Model

4.3. Relations and Roles

Social networks have a set of relations that define how people can connect inside that network. Relations belong to relation domains such as collaboration, leadership, problem solving, information sharing, team working, friendships, etc.

Relations have different roles that are associated in relation extremes. Each relation can have a plenty of roles associated in its extremes, for instance, teaching relation should have an extreme for the student role and an extreme for the teacher role. The directionality of the relation is defined in its extremes also: in a directional relation an extreme can play a sender role and another one act as the receiver role. Each relation has a property set that can also be shared between relations and each relation instance will fill the properties defined on it. In the example given the teaching relation can have, for instance, associated a property set with the following properties: course duration, course description, final grade, subjects, etc.

Relation instances represent an association between people playing certain roles in defined time occasions. Relation instances have property instances of the defined properties in the associated relation property set, for instance "*Knowledge Management*" as the course description or "*one year*" as the course duration. Associated with each relation extreme instance are one or more social entities and possibly a context. Contexts defined as part of the social network can group different type of relation instances that happen in a certain context as a specified project, in a specific course, during some event, etc.

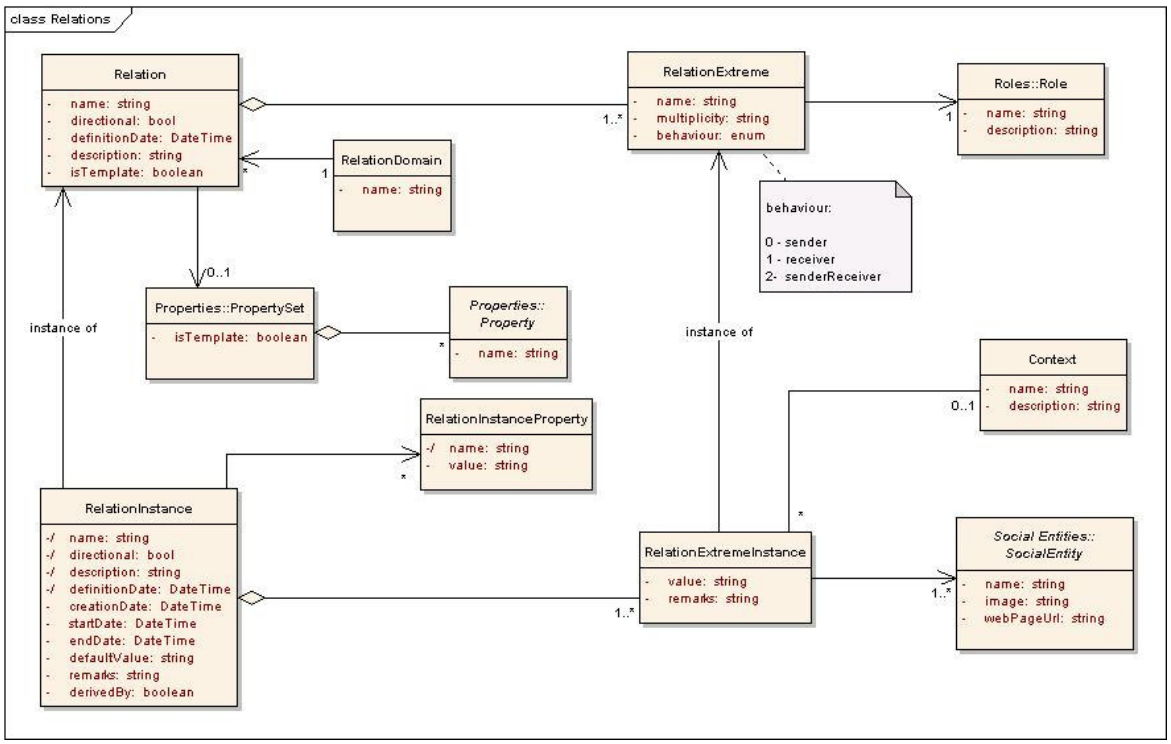

Figure 16 - Relation and Roles Domain Model

4.4. Properties

Properties represent a way to semantically enrich social networks, relation instances and social entities. Each of these entities has a defined property set that can be individual or common and that join a group of properties that can take values in instances. Properties can also be shared between one or more property sets and can be grouped in property groups designed using the composite design pattern (Figure 17). Each relation type has a property set with properties that its instances can fill with values. Every relation instance of this type can only have values for the properties defined for this relation type.

Properties can belong to one or more property sets, and at this creation we assure that its name is unique for each property.

During analysis phase or to perform searching in the network properties can be used to select entities that have specified property with a determined value or with similar properties with different values.

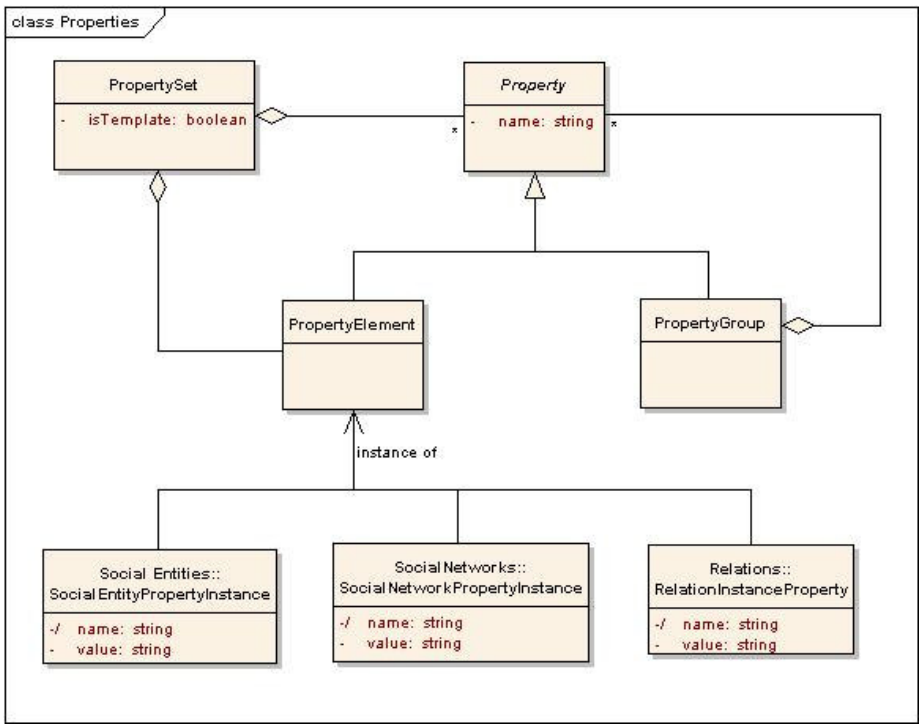

Figure 17 - Properties Domain Model

4.5. Surveys

Surveys are designed to find information about social networks based on their members' opinions and awareness. SNARE social network model have a survey module that directly connect questions and answers to social entities, relations and their properties (Figure 18). Surveys are composed by questions and that have different types and different goals. Questions can be defined just to infer some notions about social entities opinions but can also directly create relations instances or properties based on the answers (Figure 19). Some closed questions can have a set of default answers that can be expandable by users.

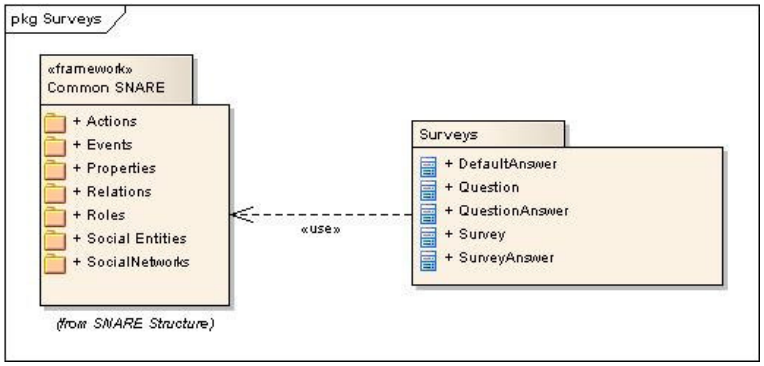

Figure 18 - SNARE Surveys Dependence

Surveys answers are done by social network members and join a set of answers to the survey questions. These answers can be open answers, introduced by the member that is answering or based on the default answers defined in the question.

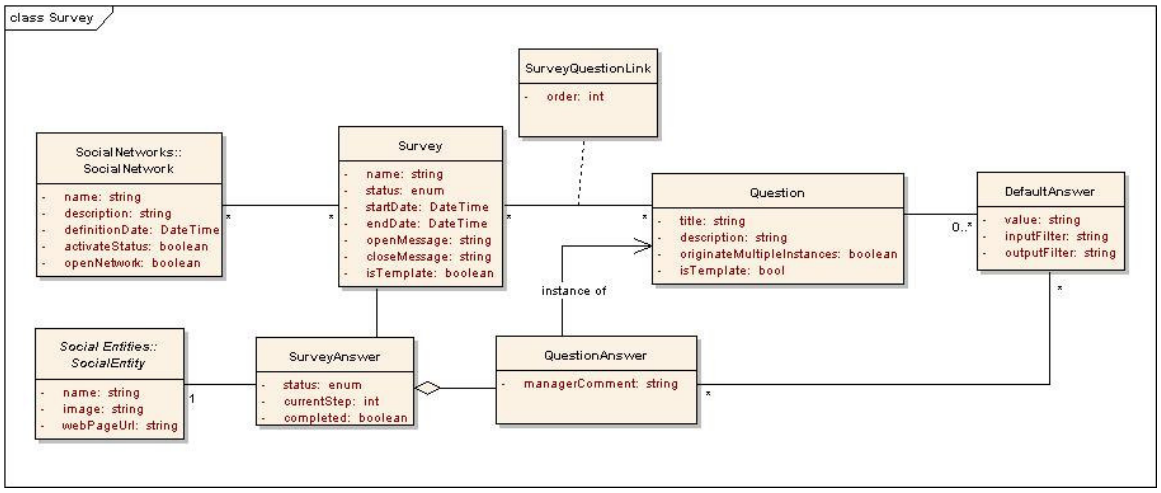

Figure 19 - SNARE surveys domain model

Questions and answers can have different types and have direct connection with social entities and relations. Questions are designed using composite design pattern, so they can be joined in groups in order to analyze specific information in each group (Figure 20), for example "*Questions about trust inside network*", or "*Questions to evaluate innovation sources in all departments*". Questions have a defined order inside each survey in order to permit build surveys where questions have relations with previous questions.

Questions can have open answers, for instance "*How would you describe the general ambient in your department and what would you think that should be improved?*", but can have closed answers , as a "*Which is your department ?*" and a set of answers "*IT, Marketing, Logistics, Finance*". Questions that have open answers are open questions and their answer instances are open answers. Moreover, questions with multiple choices are closed questions and their instances are closed answers. Closed questions can also be expandable questions, i.e. members can define a new answer that does not belong to the default answer set. Also exist rank type questions, where members can rank the defined options in a defined range, for instance, "*Rank from 1 to 5, the trust level you have in the following people: John, Peter, Bob and Alice*". The default options in closed questions are named default answers. The kind of questions can have a maximum and a minimum of answers that a user can choose.

We wanted to relate questions with previous answers done by the user to permit infer data from answers based on previous answers. Imagine that we wanted to understand to whom people turn when they have problems in a defined set of domains. We want to save that *Mary* asks *John* when she have problems

with her computer, but by other side she demands *Peter*'s help when she need to find some information about the clients.

SNARE social network surveys model supports hierarchical answers, what means that some answers are only available to members if they previously chosen a defined answer. In this case we knew that people ask people from the IT department when they have any problem with their computer, so we can define a parent default answer "*Computer problems*" and put the people of IT department as possible child options. Other default answers could be "*Legal Problems*", "*Integration problems*", "Accounting*Problems*", "*Lack of knowledge about the client domain*" and all of them could have different child options.

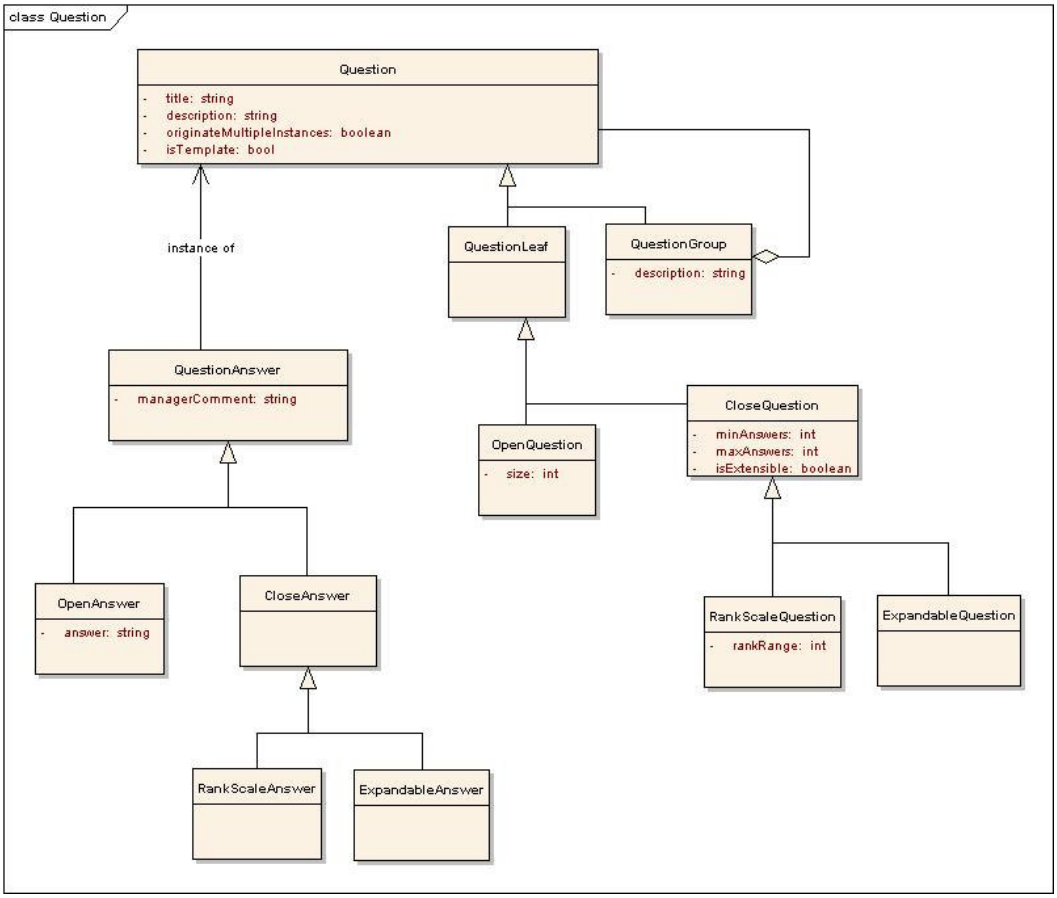

Figure 20 - Questions Domain Model

It is not very user-friendly if we wanted to define all the persons in the network as default possible answers of some questions. That is the reason why we define default answers with filter capabilities (Table 2). We wanted to define specific possible answers that expand to all people in the network, or only people with certain characteristics. Imagine that we want to define as a possible answer all the people in the IT department. It would be very slow to define everyone as a possible answer, if the IT department have dozens of employees. Default answers have an input filter that can be configured to extract social entities from the social network with some characteristics.

Input filter	Description
All	Select all the social network members.
Persons	Select only persons of all the members.
Groups	Select only social network groups.
Organizational entities	Select social network organizational entities.
External entities	Select social network external entities.
From group	Select all the members from a defined group.
With property	Select all the members who have a defined property with a defined value.

Table 2- Question Input Filters

In order to be possible to automatically infer information about possible relations and properties in the social network is necessary to relate questions and answers with relations and social entities. Questions should be related with a relation type to be inferred and should be indicated how the roles will be filled in the relation instance. The relation instance produced will have two roles, one played by who answered and the other one by the person selected as an answer. Default answers can be connected to social entities in order to produce relations when are chosen.

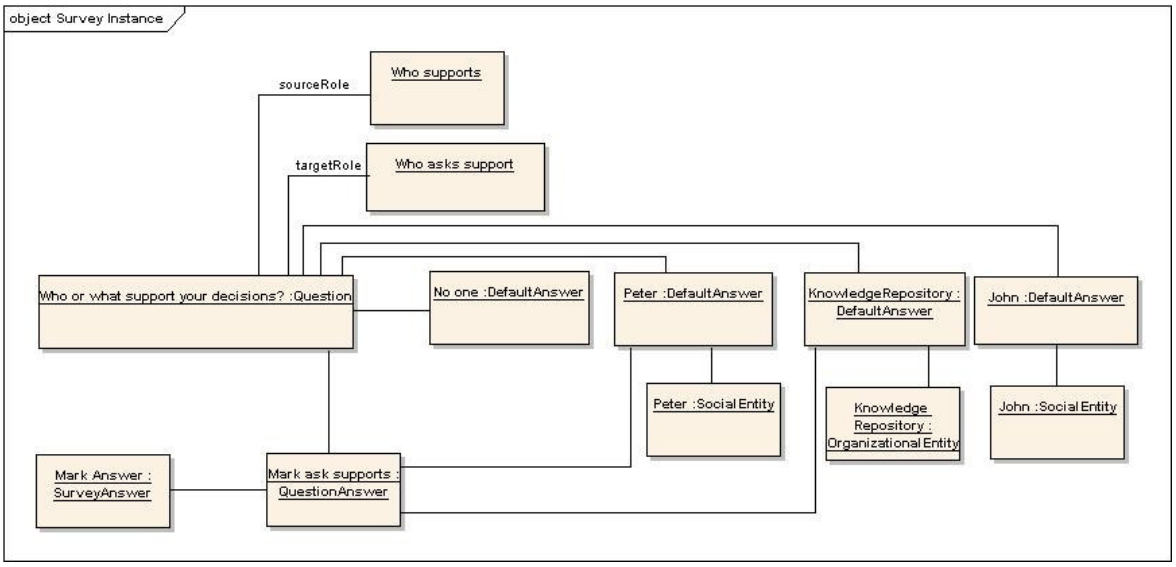

Figure 21 - Question Object Diagram

The model in Figure 21 illustrates how a question is mapped in the social network model: source role is linked with a source relation extreme instance and with the social entity that answered. The social entity associated with the option chosen is associated in the target role in another relation extreme instance. Directionality respects what was defined in the relation definition and in the question association. If the answer chosen is not connected with any social entity no relation instance is created.

In the previous example *Mark* answered that who supports his decisions in the organization is *Peter*, his boss, and the expertise he gains analysing past decisions in the enterprise knowledge repository. This answer would be converted to two relation instances of the type decision support: one between *Mark* and *Peter* and another one between *Mark* and the *Knowledge Repository*.

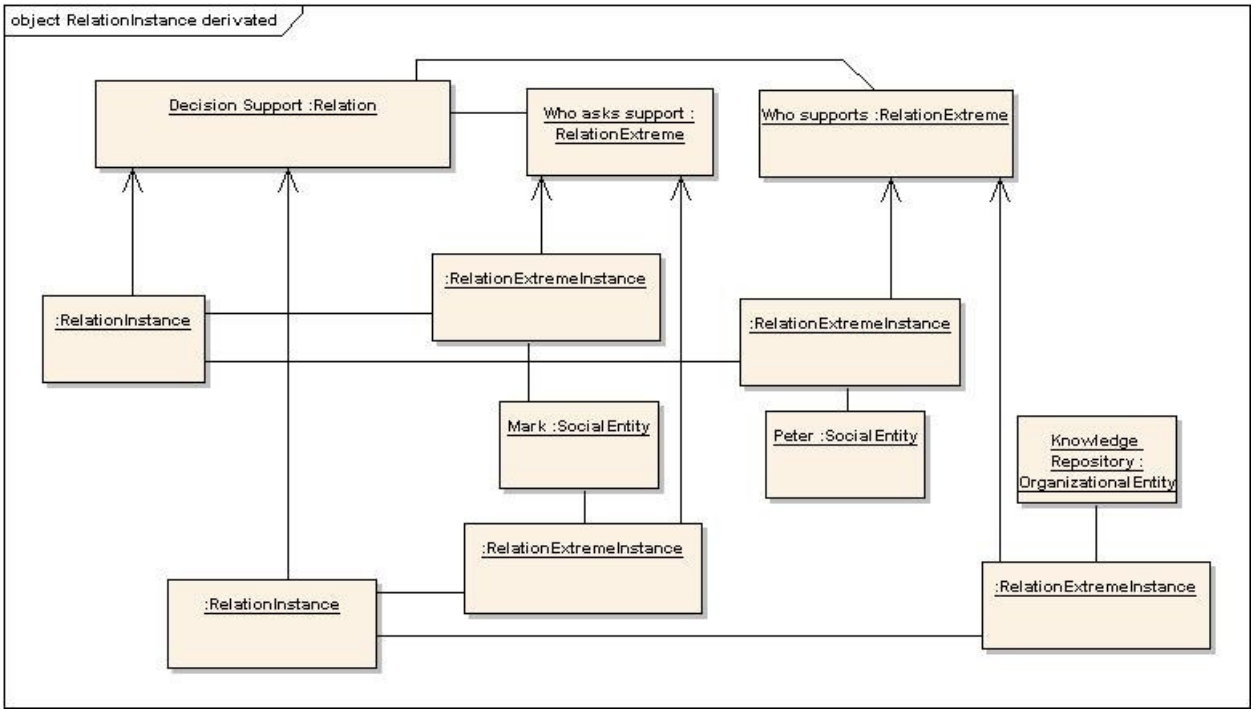

Figure 22 - Survey conversion to social network core concepts

Surveys have also the ability to infer relation instances properties and social entity properties. Default answers have an output filter attribute that can be filled with a regular expression in order to control its conversion output. If a social entity property is chosen in the output filter the answer value will be converted to that property value.

SNARE surveys support the existence of hierarchical answers, and to convert this kind of answers to SNARE social network model it uses relation instances properties as output filters. In the question "*In which contexts you find lack of support inside the company and who helps you?*" the parent default answers can be "*IT questions*", "*Legal questions*", "*Financial questions*" and the child default answers can be all the social entities. The relation instances inferred from this kind of questions will be between the social entities that answers and the child default answered selected. However, a property context will be filled with the value of the parent default answer selected. If *Mark* selects that he finds lack of support in the IT domain and that ask *Peter*'s help, a relation instance would be created between *Mark* and *Peter* with relation type "*Helping*", and with a context property filled with "*IT*" (Figure 22).

5. General Architecture and Technical Details

In this chapter we present SNARE high-level architecture, drilling down to its technical design and general behaviour and enumerating SNARE features and benefits in different categories and scopes.

5.1. SNARE High-Level Architecture

As explained in chapter 3, SNARE social network model should handle social networks in different contexts and perform extraction, analysis and transformation of social network data by different actors with different backgrounds.

We chose to follow Service Oriented Architecture (SOA) [17], building SNARE core functions as web services that can be used by other applications specifically developed with different goals. This option drives us to build a unique application to social network management that present a set of benefits:

- **Reusability:** SNARE can be easily extended without the need for redefine core concepts, or reuse code and share information about social networks in different platforms and views. Applications instead of include code or libraries will connect to services with well define inputs and outputs.
- **System heterogeneity:** Using web services to expose SNARE functions give us the possibility to develop applications in different languages, systems and locations maintaining common data, most of the time without using heavy computational transformations. Applications can be developed taking advantage of technology adaption to different needs and goals. Web applications enable global access to software by different agents with different roles in any worldwide location using a common browser. By other side, desktop applications gave powerful interfaces that can be used to visualize social networks and perform extensive social network analysis showing results in different interactive ways.
- **Abstraction:** This kind of architecture eliminates the dependence of core layer implementation allowing consumer applications to be built without understand technical details.
- **Data transparency:** All information produced by web services is in plain text xml that can be parsed by most programming languages and understood by human observation. Web services use common World Wide Web ports and are not blocked by organization firewalls.
- **Safety:** Services are accessed only by authorized applications permitting to customize access to different modules based on needs and permissions. Permissions defined in social network management are fully respected.
- **Loosely coupled design**: Features are grouped in web services with same functionality scope permitting applications to use only the necessary services. Web services are independent between each other.

Figure 23 represents the general SNARE architecture and the dependencies between different applications.

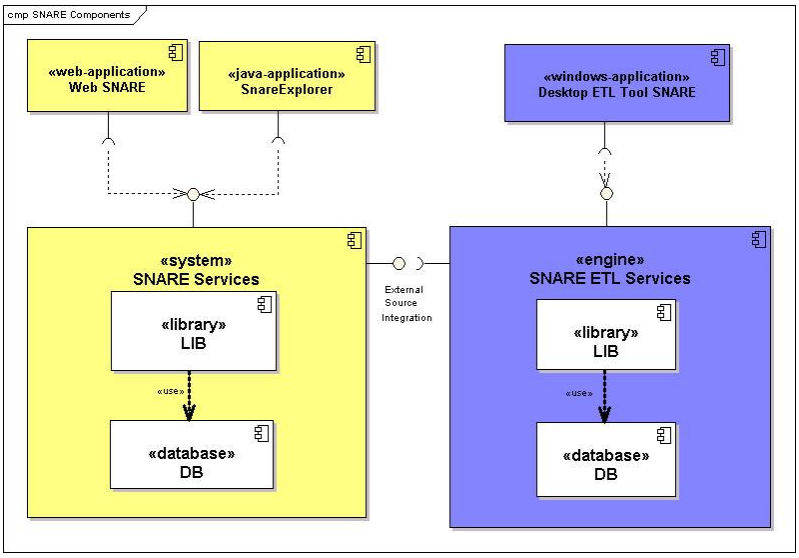

Figure 23 - SNARE high-level architecture

The set of web services called SNAREServices represents the core of any application that interacts with SNARE. WebSNARE is a web application that connects to SNAREServices and provides a web interface to social network managers to build their organization network, define relations, social entities, properties and surveys to infer interesting conclusions. WebSNARE can also be used to define social network that work as social networking services permitting that users browse though the network social entities' profiles and connect to them, defining new relations, or share information in public or private spaces. SNAREExplorer is a Java application that can be executed in any computer where java support is installed and that can be used by social network analysts or consultants to visualize and analyze social networks present in SNARE. SNAREExplorer contains modern visualization algorithms to represent social networks in graphs distributed according the closeness between them and is able to analyze networks and output the most common social network analysis measures.

SNAREMining is still not developed but its intention is to plug into existing information systems or communication servers and extract and transform data to connect into SNAREServices to build and populate social networks.

The work done during this master thesis dissertations is focused in the development of SNAREServices and WebSNARE, leaving SNAREExplorer and SNARE Mining Tool to other research works.

5.2. SNARE Core

SNARE core contains a library with the basic functions to manage social networks, social entities, define type of relations present in the network and instantiate different relations and all the properties associated with them. Moreover, it contains also services to manage social networks surveys and a set of functions to help the management of the social network in a social networking service, like relation requests, group association and management and general communication between social entities.

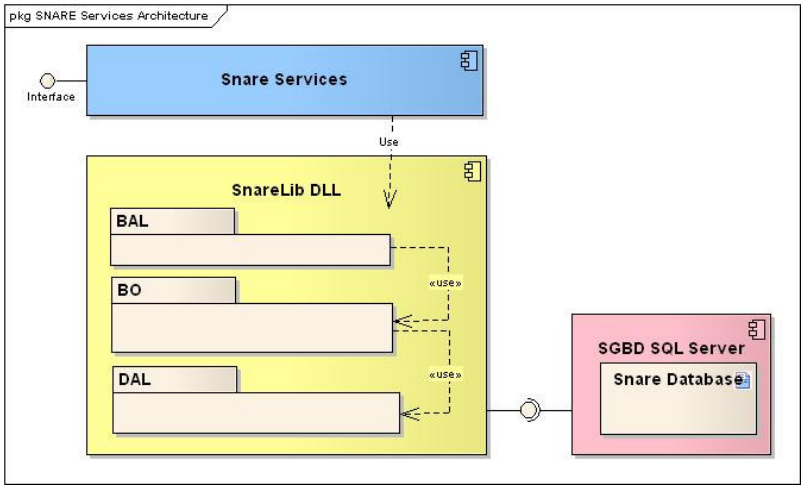

Figure 24 - SNARE core architecture

The application is structured in several layers and components to distribute responsibilities and separate concepts (Figure 24).

5.2.1. SNARELib

SNARELib can be seen as the real SNARE core where all the business entities that relate with the database and all the functions to manage this information are presented. SNARELib is a code library (.dll) developed in C# .NET that can be included by other projects that want to use SNARE core functionalities, and contain three different packages that use the lower layers: Data Abstraction Layer (DAL) on the bottom, then Business Objects Layer (BO) and Business abstraction Layer (BAL) on the top.

Database Structure

SNARE uses a Microsoft SQL Server database to persistently store business data. In Annex 1 are contained some database schemas that show the database design.

Microsoft Sql Server provides a useful feature permitting cascade updates on related tables. This enables us to maintain database integrity on delete and update operations performed on related tables, as connections between social entities and social networks.

Sql Server stored procedures control access to tables and any access of the database access layer is made calling different stored procedures for each table. There are four stored procedures for each table in the database, responsible for inserting, updating, deleting and loading all the table rows or only one with a specific primary key. A future database migration to other database management system (DBMS) can be easily done if the same stored procedures are defined because they work as a functional interface to every table.

These database stored procedures are automatically generated using code templates and are called in the SNARE Database Access Layer.

We opt to represent domain entities in several classes that can be used as business objects. To achieve this, a code generator is used in order to produce business classes directly from the database. MyGeneration [73] is a flexible and open source code generator that produces business objects in different architectures from code templates that can be used by third party applications to encapsulate and abstract database access. Doodads is an elegant .NET architecture available in C# and VB.NET and capable of supporting any .NET managed provider. It is an open source project that can be freely used and was already been adopted in other projects in the information system group which motivated us to use it in the SNARE design.

Data Access Layer (DAL) contains all the classes responsible to connect to the database and that act as Data Abstraction Objects in every database access. These classes call database stored procedures used to formalize table access.

Business Objects (BO) are classes that represent domain entities that can be manipulated by the application as objects with properties and methods. Business objects follow an approach based in Active Record pattern but have some particular characteristics. As Doodads architecture does not support entities created using queries that join tables, we define a set of views to which we construct business objects based on more than one table. In this layer are found all the entities that make part of SNARE domain, including classes for social networks, social entities, relations, relation instances, surveys, and all their properties.

In the **Business Abstraction Layer (BAL)** are present the methods that perform actions on these business objects. Different classes compose this package: social network, social entities, survey, system roles, relations, relation instances, properties and a miscellaneous class. In each of this class we can find methods to create, edit, and remove entities, to manage associations between them and to get information in data views that can be used by other applications. Therefore, these classes use business objects manipulation in order to obtain the desired business logic. All the functions that create or edit entities return the database id of the entity manipulated and the functions that get some information from the database return the corresponding Business Object that can be properly used as a normal .NET dataset. This detail is very important because enables any .NET application that uses SNARE Lib to use

data directly bound in .NET controls and don't need to have any concerns apart from data presentation. Unfortunately, as with join queries, Doodads architecture does not support relations one-to-many or many-to-many in its business objects. We overwhelm this problem by defining new data columns in the parent business objects filled with data views of the child business objects. The transformation for hierarchical data is automatically done when it is bound in any .NET control which enables SNARELib to easily output and convert complex data.

As stated before, different goals and requirements, drive us to choose SOA architecture, however there is no limitation to the direct use of SNARELib in any .NET application, and would present other advantages as more efficiency and less computation when we face .NET development. However a web service layer encapsulating SNARELib presents a set of bigger advantages that make us to choose it.

5.2.2. SNAREServices

SNAREServices is a web service application developed in c# that imports SNARELib and basically constructs a web service to all relevant methods that we want that third parties application use and adapt their return type to a web service perspective.

SNAREServices are composed by three web services that join methods by different scope and their probable use by other applications.

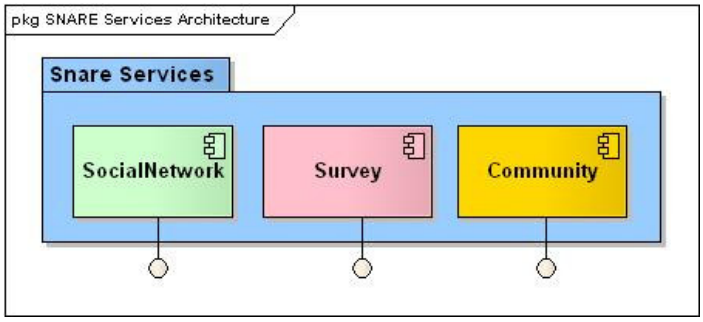

Figure 25 - SNARE services composition

Figure 25 represents the different web services that make part of SNARE Services. SNARE Social Network Web Service exposes the functions to manage a common social network and its social entities, relations and properties. By other side, Survey Web Service exposes all the functions for managing surveys and Community Web Service contains all the methods to manage a community based in a SNARE social network.

Data transparency is one of our main goals and all information returned by web services should be transparent enough that it could be adapted by different platforms developed in different architectures and technologies. A main challenge was to find a way to represent complex hierarchical business entities into plain text information that could be easily parsed and understood by other applications.

Doodads business entities can be translated to xml representation but some of our requirements are not satisfied by this solution, namely hierarchical business objects and objects with null fields. Therefore, a new method (*toXmlWithNull*) is developed to convert business objects to xml: object fields are converted to child nodes and the ones with null values are also included but with an empty value; hierarchical objects are represented in nested hierarchical nodes. A special attention is dedicated in this last detail derived by .NET ability to automatically build a new dataset with tables and relations from a correctly nested xml code. This saves us to deal with all the parsing process of the xml code returned in any client applications.

Figure 26 represents a code snippet from the return of the method *getPerson(intpersonId)* and show us how data is mapped in a xml node.

```
<NewDataSet>
    <ViewPerson>
        <SocialEntityID>89</SocialEntityID>
        <name>JoãoSaraiva</name>
        <image>joao_saraiva_2008_06_01_thumb.jpg</image>
        <WebPage>http://picasaweb.google.com/saraiva_joao.jpp</WebPage>
        <PropertySetId>5</PropertySetId>
        <type>Person</type>
        <telephone>123456789</telephone>
        <postCode>1150-180</postCode>
        <gender>male  </gender>
        <birthDate>08-02-1979 0:00:00</birthDate>
    </ViewPerson>
</NewDataSet>
```

Figure 26 - Web service output example

Web services consume input in standard forms as strings, integers, booleans and output the same type of data and also xml code representing business objects.

Authentication

SnareServices use customized headers with authentication credentials to assure that only authorized applications can connect. The .Net Framework lets the definition of custom SOAP headers derived from *SoapHeader* class in order to verify the credentials provided.

Configuration

SNARE Services has a configuration file where can be defined the database connection strings that should be used in SNARELib to connect to the database. It contains also the information to correctly connect to a SMTP Server to contact social entities by email.

5.3. WebSNARE

An important requirement on the basis of SNARE construction is the ability to receive the contribution of all social entities present in an organization to the build and maintain a social network. Therefore it is natural to choose the development of a web application by its adaption to our goals, namely:

- **Global access** – Easy access by any computer with Internet connection.
- **Cross platform compatibility** – The application can be executed independently of organization systems and users' operating systems.
- **Simplified management** – Web Applications need only to be installed on the web server placing minimal requirements on the end user workstation what simplifies the system development and maintenance. Any platform update needs only to be deployed in the web server.
- **Members' interaction** –Every organizational member can access his personal area and interact in the system live, watching everyone contribution.
- **Users experienced with web interfaces** – People use web sites, communities, bulletin boards, and social networking services everyday and their learning curve to a common web interface would be smaller.

WebSNARE is developed on top of WebComfort, a Content Management System (CMS) initially developed at Information System Group, and currently used in different academic and commercial applications [74, 75]. WebComfort has built-in features such as user management and role association, page creation with customized access, and a rich set of usable modules as announcement management, image galleries, menu creation, calendars, and document and link management. It can be customized using visual themes that group master pages, images and Cascade Style Sheets and are able of running multi-language web applications where all content can be translated in different languages. Websites are organized in tabs that contain default containers to modules associated with that tabs. A powerful hierarchical role mechanism is present, enabling customized access to tabs and modules present to users with some role association.

WebComfort can be extended with the definition of new modules that add new features and functionality to the system and can interact with application using a defined API to manage users, roles, and tabs or change general features and navigation. Modules can be grouped in toolkits that can be easily installed in different web comfort deployment instances.

5.3.1. WebComfort adaption

In order to extend WebComfort for adapting to SNARE, a set of new modules is developed to allow access of different organizational actors to social networks, browse information and interact inside them. Moreover, other transformations were done like web services integration, and a common API usage to simplify user and network integration.

SNAREServices Integration

Using Microsoft Visual Studio simplified the integration of SNAREServices with WebSNARE. The process is based on the inclusion of the web services as web references. Microsoft Visual Studio imports the WSDL reference and after generating stubs for all methods, web services become available in the chosen namespace.

User Management Integration

WebComfort provides user management and their association with system roles. To provide access to all social entities to the system, an association table is defined to associate SNARE social entities and WebComfort users. As required, it is possible to create social entities without access to the system, just to analyze their relations, but it is important that, if necessary, users can have a system account and interact in the system. SNARE social network system roles are directly mapped in WebComfort and information about roles assigned to different users is also saved. A manager, for instance, is a WebComfort user that has a manager system role assigned. The same applies for members, analysts, and operators. Administrator represents a system role only defined in WebComfort because are not directly related with a social network, but with general system configuration.

Profile pages will be presented in detail later, but it is important to explain that to build personal profiles for each user we decide to construct a single tab for each user populated with defined modules that can be customized. This option allow us to save work, by using web comfort modules for announcements, links and documents and allow each user to have his personal profile page, customized as in common Social Networking Services.

Security and privacy are requirements that driven SNARE development since the beginning and we wanted to assure that users are able to show their personal information only to who they want to allow. Specific roles are defined for social networks and group members what allows that someone only access some part of the system if they are currently a member of a determined network or group.

5.3.2. Social Network Integration

In WebSNARE a user after logging in, should select a social network where he wants to interact. This information is saved in session variables and it is verified in every module. The content of the list of social entities or relations is totally dependent of this information. We are very conscious in do not show information outside the network.

Each social network has also associated a system role that permits that some content can be only available to its members. In order to improve communications between network members a module for news that managers can use to announce content is present in all members home page.

5.3.3. Layout

WebSNARE pages contain three well defined navigation areas: a top banner identifying the project and the current user together with links to all main areas of the application; a central content pane that contains current page content; and a footer that usually contains project information.

Figure 27 - Web SNARE layout

A snapshot of the welcome page for a social network manager is presented in Figure 27 as an example.

The navigation is basically done using the top banner: in zone 1 are present the navigation tabs to pages that contain profiles, social entities, relations, surveys and social network management. A *PortalAdmin* tab is present to the application administrators, in zone 2 is identified the current user and are present quick links to home, options, and tab editing.

The central pane is personalized in every page, containing the modules present in each tab. It is usually constituted by three vertical panes, where left and right page contain specific navigation menus. These modules can be shown only to some type of users customizing page look.

When user accesses Web SNARE for the first time, the homepage presents a login box and information about the SNARE project, together with a list with statistics about social networks registered in the system as the number of social entities and relations. An unauthenticated user can also browse public social networks and join them, or can request to join semi-public networks what will happen after manager

approval. After logging in, he is redirected to a member homepage as the one represented in Figure 27. Before navigate to any page, user needs to select an active social network, what is done in region 6. Important modules inform the user in the homepage about what is happening in the social network. In region 4 are present his contact updates together with the current social network news, broadcasted by managers and in region 5 are represented alerts about requests he should reply, like survey answers or relation requests, and network and group membership requests. In region 7 all of his groups are present allowing him to easily jump to their profile pages.

The structure and module constitution of each page can be customized in all SNARE instances, allowing administrators to change default look and feel.

SNARE Theme

A special WebComfort theme is created to represent SNARE default look and feel. We chose a set of colours from blue to gray to define main theme colours because they are more adapted to professional contexts.

This theme contains a unique cascade style sheet allowing us to change default WebComfort look: the top banner contains a big image with a blue gradient identifying well the project; the navigation banner tabs are dynamic, reacting to mouse pointer passage; quick links are shown aligned in the right; the modules identifications are larger and adapt to general look and feel. Small icons are used to identify certain actions like edit, delete, add content, or to manage certain items.

SNARE theme contains a personalized Master Page, with 3 vertical panes in central area, occupying 90% of the page horizontal area, but showing a gray gradient in the background. Moreover, SNARE theme contains a personalized edit page, simplifying the default one used in WebComfort, by not showing information about multilanguage or specific web comfort options. Finally the banner is also personalized in order to allow us to define different content from the default define in WebComfort.

5.3.4. Modules

A package view is represented in Figure 28 and shows a vision of the developed modules grouped by capabilities and functions. All developed modules were included inside a new module category named SNARE Modules.

We want to keep application logic as much as possible in SNAREServices, and develop other applications that consume and produce information to this application core, so it is natural that most of the modules developed only show information from SNAREServices and manage information on them.

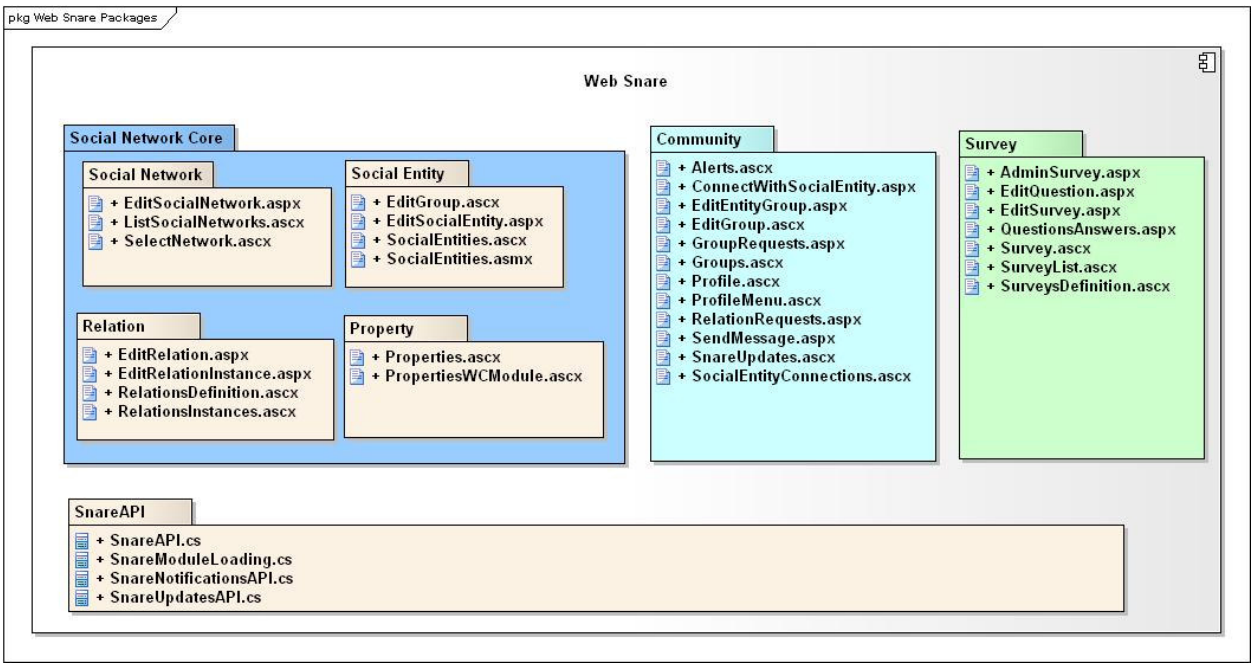

Figure 28 - WebSNARE modules

Social Network

Social Network management can be done in the tab *Social Network*, accessible from the tab banner. In this tab, managers can edit current social network description and options and manage social network news. Figure 29 represents Social Network Package, which is composed by three modules (*listOfSocialNetworks.ascx*, *editSocialNetworkNews.ascx* and *socialNetworkProfile.ascx*) contained in two tabs and in one dynamic page (*EditSocialNetwork.aspx*).

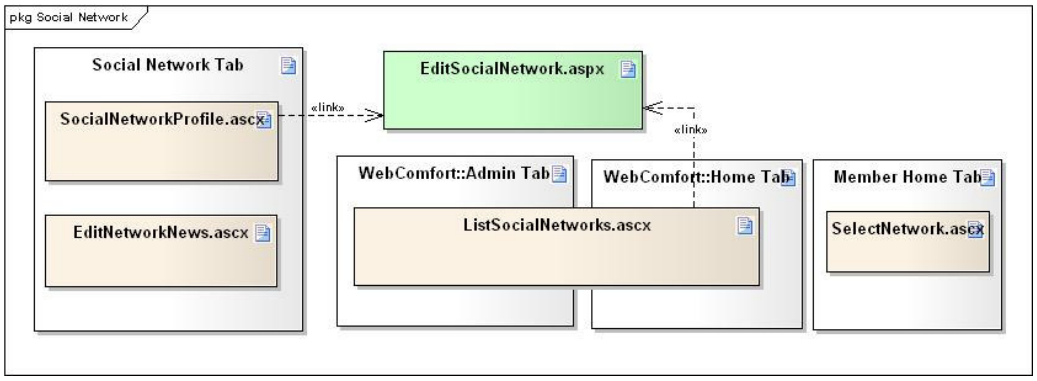

Figure 29 - WebSNARE Social network package

The module *ListOfSocialNetworks.ascx* is configured to show a different list of social networks to users with different roles: administrators can see all networks in *PortalAdmin* tab, while members can only see public networks in *Public Networks* tab, and not authenticated users cannot see hidden networks in homepage statistics.

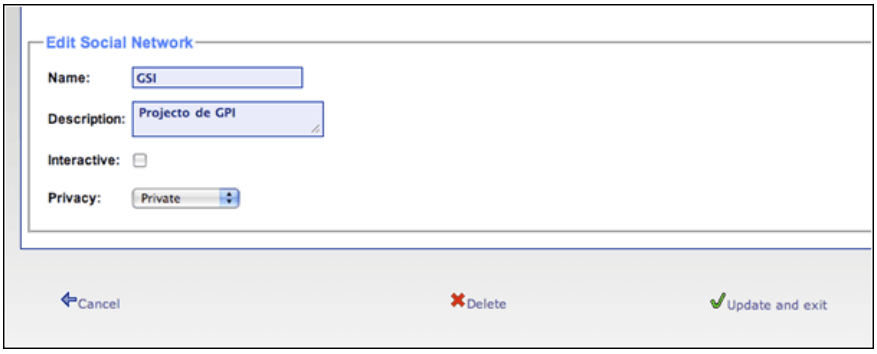

Figure 30 - Social network edition

In Figure 30 is represented the social networks edit page (*EditSocialNetwork.aspx*). Social Networks can have different privacy policies that influence how member can join or discover the network in a SNARE installation. They can be defined in social network options by managers or administrators:

- **Private:** Only members can access to social network pages. A member can only be registered in the network by the manager, and cannot request to join it. The Social Network name and data is available in the total statistics.
- **Private and hidden:** Similar as a private social network, except that its existence is totally hidden, and do not appear in total statistics.
- **Semi-public:** The list of network social entities can be browsed by everyone and everyone can request to enter in the network, what happens on manager approval.
- **Public:** Everyone can browse inside that network, and can even join automatically without anyone authorization.

Apart from the name and description field and the privacy selection drop box, is available a checkbox that defines if the social network is interactive. This property configure if members in this network can connect, and contact other members using their profiles, or if they can only register and personalize their information. This option should be selected in cases where social networks will function as communities like in a Social Networking Services.

Social Entities

Social entities package allows social network managers to create or associate social entities within their social network. This package is composed by all the profiles of all entities and one tab that contain a list all the social entities, and links to an edit page, only accessible by managers (Figure 31).

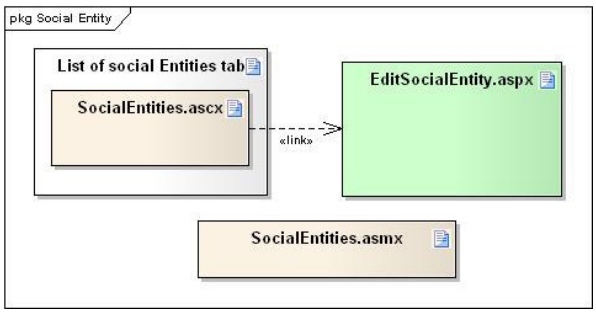

Figure 31 - Social entity modules

The social entities list is accessible by members and managers, although different views are available to the two types of entities. Managers are able of seeing all the social entities linked to the social network, joined with their system roles. Besides that, managers can select multiple social entities and perform a simultaneous action on all of them like delete from social network, generate and send new passwords together with a welcome message, and regenerate user profiles.

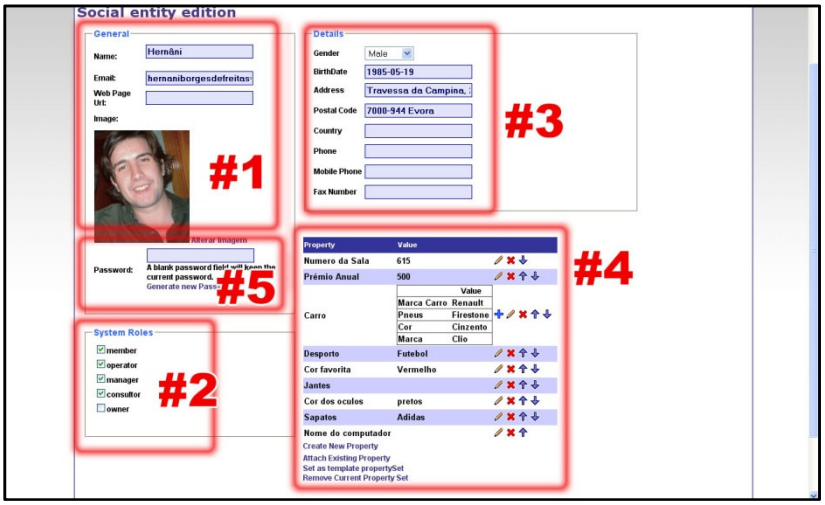

Figure 32 - Social entity edition

Clicking on a social entity edit icon or by creating a new social entity, the manager is redirected to the edit page (represented in Figure 32), where he can edit several aspects:

- General social entities details, like name and image (region 1).
- Specific social entity properties like birth date and gender for persons, or members for groups (region 3).
- Define social network system roles (member, manager, operator, owner, and analyst) in region 2.
- Define if that social entity has a system login and if so, define or generate a password (region 5).
- Create or remove a property set, or associate a template property set; create a new property or assign a template property; edit property instance value and privacy permissions (region 4).

As already said each social entity can have an associated user with system roles defined. Figure 33 shows how table *SNARESocialEntities* is used to keep this information. *LastLoginTime* and *LastLoginIp* fields are used to save information about last user login.

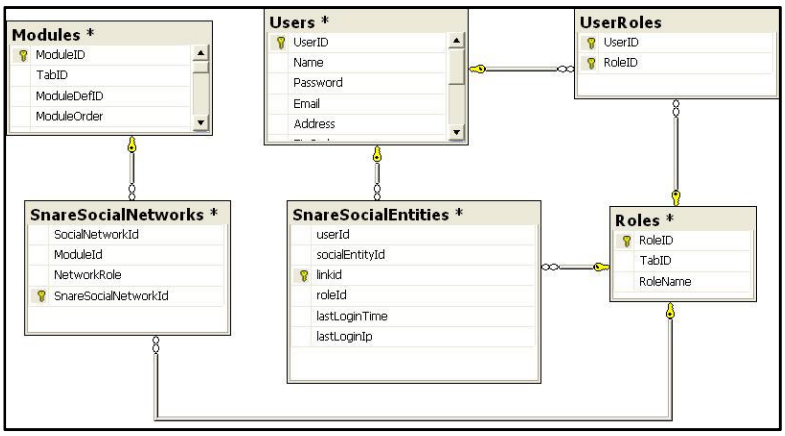

Figure 33 - Database diagram for SNARE social entities

When a social entity is created it is automatically associated with a "*tab edition*" role. This is the role responsible to edit all the content of their profiles. If a password is supplied, a WebComfort user with a proper login is created and associated with the chosen systems roles, the "*tab edition*" role, and other system roles as network member, or group membership role of the groups where he is a member. If no user is created, the association is defined with the user field filled with null vale, but keeping edit tab roles, allowing a future user association.

When an existing social entity is edited, her information is loaded in the edit page, and their system roles are automatically selected. If the social entity has an associated user, a change password field is present alerting the user that keeping the value in blank will not change the password. If there is not an associated user, it is possible to create one and define or generate a password. In this phase the user is created and automatically associated with the already existing profile tab edit role, social network membership role, and groups' membership role.

If a social entity is created directly using SNAREServices, or by some mining process for example, there are no profiles or users associated with them. This case is a good example of how user lately association is useful: all social entities imported can be selected and users' logins can be generated and send together with a welcome message to their email box, only when the all network is configured and ready to receive everyone interaction.

Relations and Roles

In the relations packages are contained the modules to define the type of relations present in the social network and it is possible to view and edit all relation instances (Figure 34).

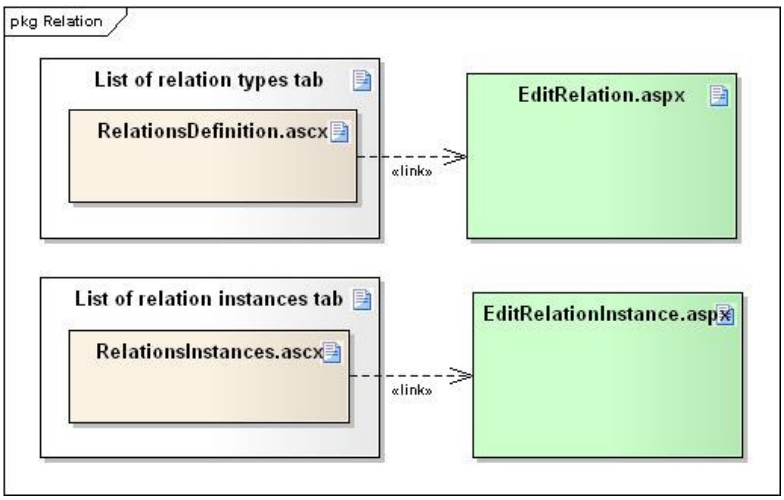

Figure 34 - WebSNARE relations package

This package is specially directed to managers and operators that can use it to define the relationships among social entities present in the social network. First of all manager should define what types of relationships can be instantiated in the social network. As explained before social networks should contain only the types of relations that make sense in their context.

Figure 35 - Relations definition

In the relation definition tab (represented in Figure 35) it is possible to define relation structure together with basic and extended characteristics: in region 1 manager can edit relation name, description, domain and directionality; in region 2 he can edit relation roles and define their behavior, multiplicity and context, and in region 3 are the properties that relation instances should fill with values.

After defining the relation types, social network manager or operator can handle the relation instances. They need to have a defined relation type and known time duration. Relation instances can be created or

imported in many ways like by direct instantiation, mining processes, survey analysis or community activity as already depicted in previous chapters.

Relations instances are listed in the relation instances tab and even if they were not directly instantiated they can be edited using the edit icon in the list that redirects the user to the relation instance edit page (*EditRelationInstance.Aspx*). In this page manager or operator can edit relation start time and end time, and can fill the relation roles with social entities. Relation multiplicity and behavior are totally respected in this area. Moreover, manager can edit relation instance properties by filling the dynamic properties defined to this relation type.

Properties

As explained in chapter 4, dynamic properties can be added to social networks, social entities and relations. Properties are defined in a separate package that contains modules and controls that are reused all over SNARE modules (Figure 36).

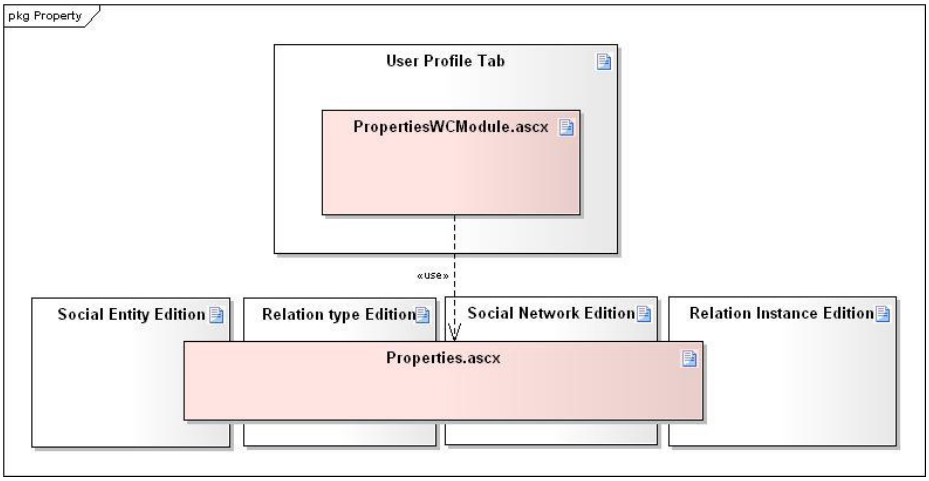

Figure 36 - Web SNARE Properties Package

The control *Properties.ascx* contains all the functionality and logic to create and remove property sets, to create and remove individual properties, change property order and privacy policy and of course edit their values.

If a property set is associated with the entity currently being edited, this control show the properties table namely the property name and value together with action icons to edit, delete and change order of properties (Figure 37). By clicking in the edit icon the user can change the property value and define the property privacy policy. This policy applies to social entities properties and defines who can edit and see the property value, according to the following table:

	Read Permissions	Write Permissions
Manager	Only the manager can see this property.	Only the manager can change property value.
User	Only the manager and the owner of the property can see the property.	Only the manager and the owner can edit the property.
Public	Everyone can see the property.	Everyone can edit the property.

Table 3 - Properties privacy policy

If no property set is associated with the current entity, the control informs that user can create a new property set or associate a template property set.

SNARE supports composed properties: this kind of properties basically groups several properties in one property group with a customized order. These properties are used to map entities that can have multiple sub characteristics: a car can have a brand, a model, a tires specification and a color for example.

After properties table, are represented the quick links to add new properties, to attach existing ones, to define the current property set as a template property set that can be attached to other entities and to remove the association of this property set with the current entity (region 2 in Figure 37).

Figure 37 - Dynamic properties

Usually this control is directly embedded in social entities, relations and social networks edition page, but is also included in a Web Comfort module that only contains this control (*PropertiesWCModule.ascx*) and is included in members profile page.

Surveys

Surveys package are constituted by the modules that allow the managers to create and administrate surveys and questions and the modules that list all active surveys and present the interface to answer them.

Figure 38 shows survey package composition and the tabs where controls are installed. Using the survey links in the top banner, the manager can access the survey management tab where he can see the list of all social networks' surveys and edit them in the page *EditSurvey.aspx.*

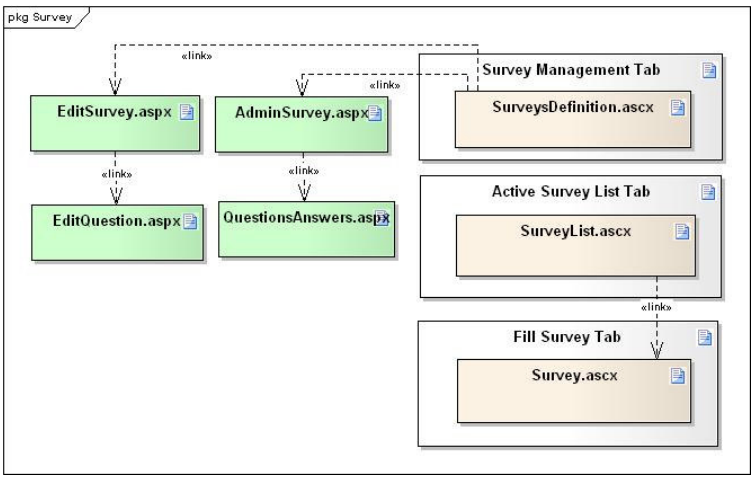

Figure 38 - WebSNARE surveys package

In this dynamic page, manager can define the survey details, the survey start date and end date, manage the questions that compose the survey and change their order. Also, manager can define the survey as a template survey that can be reused in other social networks. Questions can be added by attaching existing template questions or by creating new questions, which redirects the user to the dynamic page *EditQuestion.aspx.* The question edition page is a complex dynamic page that can edit or create all the question types supported by SNARE Social Network Model.

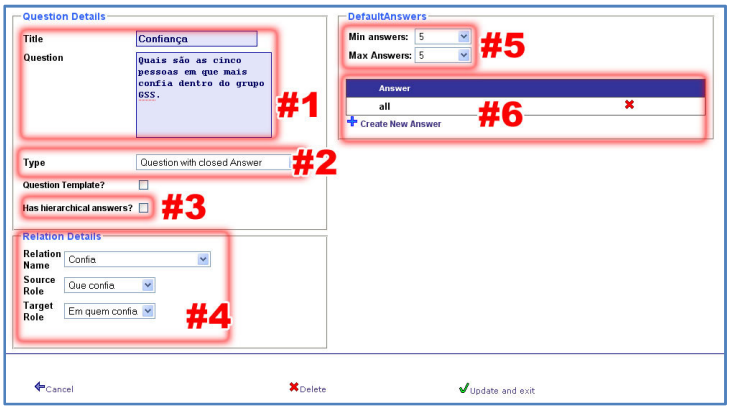

Figure 39 - Edit question example

Manager can edit question title and text in region 1 and define after the question type in region 2. The question type influences the behavior of this page: right below the question type the manager can define if he wants to infer any relation from the question, and in the right in region 5 and 6 the manager can define the default answers that will be present to the user. Only if the question is not an open question it will appear the options to create answers and derive a relationship, because is not possibly to directly infer information from open questions. When defining a question that infer a relation it should be indicated how the relation instance dyad will be filled, i.e. which role will play who is answering the question and which role will its answer play. The number of possible or necessary answers can be defined in region 5: some questions may require that users select at least a minimum number of answers or a maximum number of answers. Default answers can be defined in region 6 by directly inserting possible answers values or by selecting input filters to select social network specific members, all persons, groups, or specific groups. Also, as explained in SNARE Social Network Model it is possible to infer other information from questions that are not directly mapped as a relation instance. This can be done using output filters also defined in this area.

After survey creation, users should reply to the questions using the survey page (functionality is present in *survey.ascx*). The process steps are iterative and follow a general well defined structure. At the beginning, user is welcomed by a short introduction defined by survey manager, explaining survey goals and context. The survey is divided in a defined number of steps, with each step linked to a question. In each step the user can understand where he is, and how many steps he should still complete. The question title is present in the page header, following by the answer space he can fill. If a question is an open question a text box is present, if a question have closed answer, a list of options is present; if only one answer can be selected a list of radio buttons are shown, but if user can select more answers a checkbox list appears. If a question has expandable answers, after default answers appear, a textbox with auto complete algorithm is present, enabling users to introduce new answers. Hierarchical answers are shown not expanded in default view, but when the user select a parent answer, all their child options became available. It is important to highlight that the number of answers is checked after each step finish and only after being correct, the user can continue to the next or previous step. In the end of the survey the user receives the final message and can check the answer summary correcting his answers, if desired.

Figure 40 - Question results

Managers can follow survey results analyzing general question statistics, drilling down to individual answers, to understand general and particular results. Figure 40 shows how the question results are shown, displaying the selected answers by numbers of picks. By clicking in zone 1 the manager can see individual answers to that question. Moreover, manager can promote answers introduced by users to default answers that can be available to all users in zone 2 and can also link answers introduced with social entities present in the network. This is very helpful in scenarios where members used expandable answers control to insert new answers. Imagining that a user answered the question "*Who usually helps you when you do not know how to finish a task?"* with a new answer "*Nick*". *Nick* is a new employer at the IT department that is present in the social network with the name *Nicholas Grass.* It is fundamental that the answers directed to him are well associated to assure correct social relations inferences. Manager is able to convert the answer "*Nick"* and associate it with "*Nicholas Grass".* He can also promote the answer "*Nicholas Grass"* to the set of default answers, enabling future answers to be correctly associated with the right person.

Manager can understand how many users answered the survey and in the end of the process can perform the most important step in surveys module: all answers given by users are converted to relation instances performed by who answered and the social entities indicated, with correct properties defined. All the relation instances are created with a special tag indicating that they were derivate from the survey, allowing future operations like delete them all and redo the process. After this step, managers and analysts can use all other SNARE features to analyze the social network.

Community

Users can interact with each others in social networks where the community package is enabled. This package contains modules present in profile pages and in the homepage to show information about persons and groups, to show social entities' groups and to handle requests to other social entities (Figure 41).

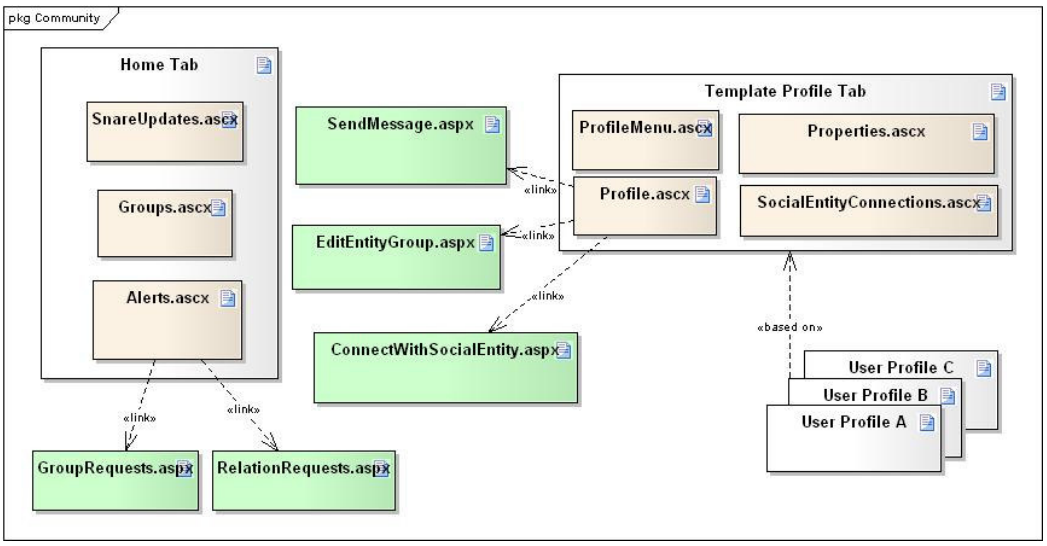

Figure 41 - Web SNARE community package

In the home page, the module *SnareUpdates.ascx* show the last updates from the user's contacts. Activities like new connections, profile edition, content publishing are ordered enabling users to understand what is happening in the network. Moreover, the module *Alerts.ascx* show any special requests that the user should reply, such as connection requests, groups requests or survey filling. This is done using dynamic pages accessible with links present in the module.

Users have a personal area, named user profiles, that they can customize and where they can publish content and other users can find information about them. User profiles are created using WebComfort tabs, allowing each profile to be customized by its owner. As we soon understood that allowing total profile customization would confuse users we opted to define a template profile with chosen modules that all other profiles use as reference. Users can only customize each module options and not the all tab.

A WebComfort tab is defined as the profile template for all others profiles. When a new profile is created or recreated, a process iterates through all modules defined in the template tab and creates a similar tab with new modules defined in the same positions. The edition role defined for this social entity together with other roles associated with the tab, allows the user to customize access to different modules to people belonging to a specific group or network.

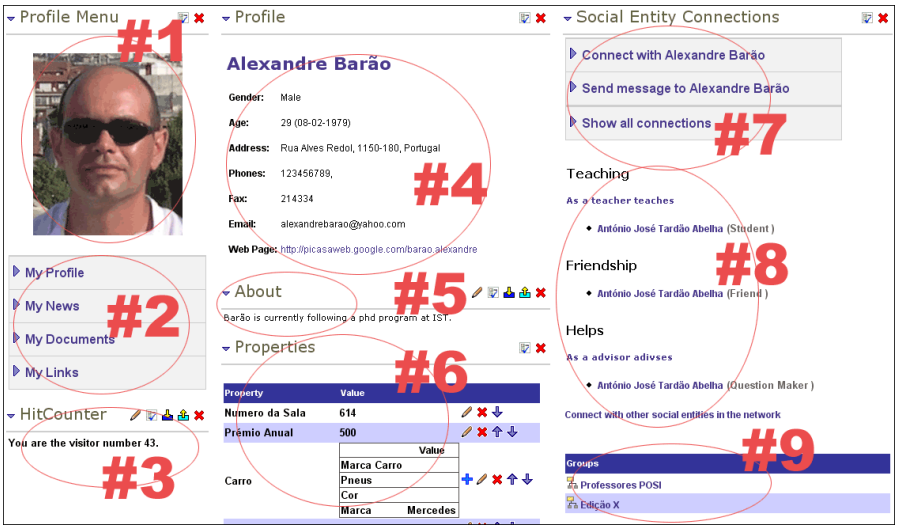

Figure 42 - User profile example

A typical profile page is shown in figure Figure 42: in the top of the page is present a user picture if it is available, or a general blue profile image if not (region 1); a menu present links to user's news, documents, and links in region 2; a hit counter records the number of hits in the profile (region 3); In the centre of the page, person details are presented together with an edit icon only visible to profile owner, where he can edit personal information (region 4); below it is available a space where users can edit a short biographic text (region 5).Social entity public properties are presented to general viewers. Other properties can be seen by profile owner and managers, depending on properties permissions. Profile owners can also edit available properties and define new properties (region 6). Using the right menu, the viewer can request a connection with the user, or can send him a personal message. If the profile is a group profile, viewer can request to join the group and group owner can send here a message to everyone in the group (region 7). All the social entity connections are shown in the right side, presenting the social entities connected with this user and the type of relationship together with the role played. An option to show only a list of connected social entities is also present (region 8). Finally, a list of groups where social entity is a member is present in the right bottom of the page. Profile owner can also browse other groups and request to join them, or also create a new group (region 9).

6. Evaluation

This chapter approaches SNARE's use in two case studies where its benefits, features and capabilities were tested and evaluated. These two experiences had different final goals and distinct features were used in order to correctly handle requirements. Both of these case studies also helped us in correcting software and interface problems and improving general application quality.

6.1. Vodafone Portugal case study

SNARE capabilities of inferring social networks from surveys answered by organizational entities were tested in a case study developed at Vodafone Portugal. This study case allowed us to study what kind of questions do managers want to understand when they survey employees about their relationships with others or about personal information. Moreover, we could access what important information is important to assess that can enable successful reorganizations or process changes. We could understand by practice how effective was SNARE Surveys module in answering several requirements and producing different inferences together with testing interfaces and processes to manage, monitor and answer social network surveys.

6.1.1. Background

This first case was developed in the "Grupo de Suporte a Serviços" (GSS) at Vodafone Portugal, a group responsible for the operation and support in networking services. GSS is divided in three functional areas: (1) **GSS Messaging** is responsible by messaging services, like SMS, Voice Mail and Unified Mail for example; (2) **GSS IN** is responsible by Intelligent Network Services as pre-paid service and (3) **GSS SAS** is responsible, for instance, by WAP services as Vodafone Live, WAP, music, ring tones and images.

All of these groups also assure problem resolution in any of the associated services, being also responsible for the technical maintenance of supporting infrastructure and execution of new application versions, upgrades or configuration changes.

GSS group is composed by 22 collaborators, most of them allocated to the different functional areas, but with some entities not playing roles in any defined area or only super visioning all of them. GSS hierarchical structure is represented in Figure 43. It is important to refer that not all the functional areas were created at the same time, and that most experienced GSS members already worked in different areas developing relationships with other persons at Vodafone Portugal.

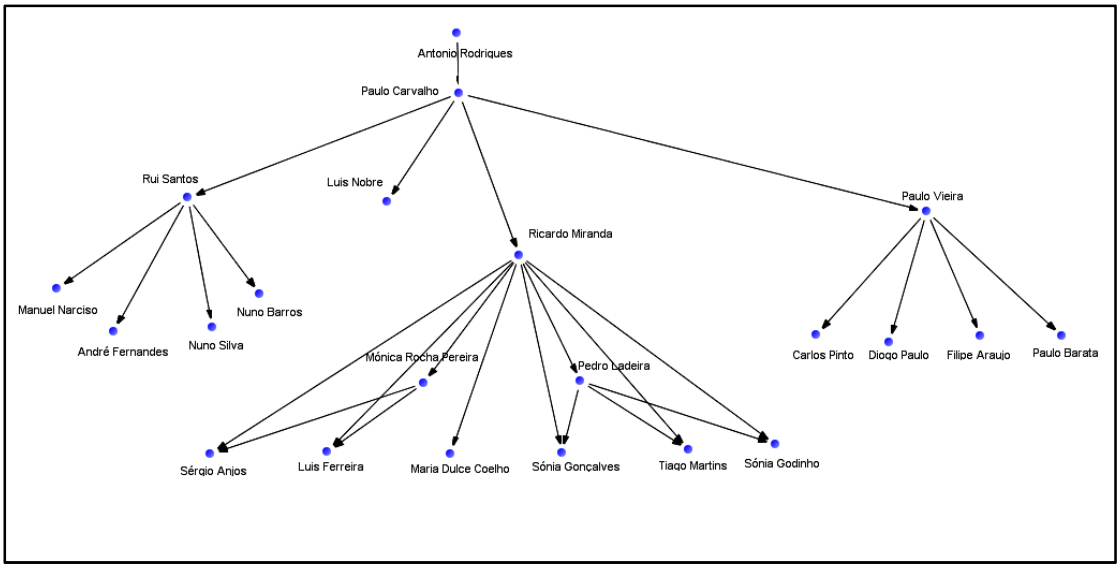

Figure 43 - Vodafone Portugal GSS hierarchy

6.1.2. Goals

GSS managers wanted to understand if Social Network Analysis could help them to explain higher performance and higher evaluations by different functional areas. Apart from that, they wanted to understand if formal groups would emerge from informal groups and, if so, they would somehow affect connectivity and performance by different groups.

They wanted also to use SNA to identify the most connected actors in the social network and in different groups and compare if these connections in positive questions are somehow connected with better performances and results. This could help them to understand if the better examples are recognized inside the group and seen as an example to follow, or if for an opposite way, people have different role examples and people less evaluated or with less hierarchical position represent important hidden connections to the correct group working.

GSS IN suffered recent changes and GSS Managers wanted to understand what was the impact of creation of two virtual teams with different concerns, specially who were the most critical elements affected by this change.

A survey was defined to allow managers to infer conclusions in questions about general trusting, identification, support, goal reaching, stability and organization change, organizational values, motivation and satisfaction.

To model as many questions as possible, defining different questions types with different kind of answers and different types of inferences and limitations was one of our biggest concerns. We wanted to test application access by different users, and SNARE's capabilities to monitor real time results, together with real time corrections to forgotten data. Moreover, we wanted also to test the easiness of survey creation

by managers together with easiness of correctly fill survey answers and general navigation questions in the network by users.

This survey worked as a first test of SNARE surveys modules and a pre test for a bigger survey to be realized after, directed to all Vodafone Portugal collaborators.

6.1.3. Planning and execution

The survey was studied and we identified for each questions how we could infer relationships or properties from the answers. Together with the manager we defined a survey structure that could make sense to who is answering, that could answer managers' questions and goals and that could extensively test SNARE platform.

A group of eleven questions was defined to infer relationships with different directionalities, properties or relationships with associated properties. In this set of questions were defined questions with open answer, with a defined set of answers but allowing users to create new answers, directly or not linked with social entities, together with group questions and hierarchical answers.

The Survey structure is presented in detail in appendix B, but our motivation was specially to find elements that according to Organizational design literature are import to characterize organizational clime or context. This aspect has a correlation with performance, but not in a causal-effect direction:

- **Trust:** It characterizes the recognition of equality and competence.
- **Identification:** This is one of the leadership characteristics. The goal is to make emerge "role models". Inverse network permits to question some group tensions.
- **General support:** It permits to measure the level of cohesion of the team.
- **Goal support:** The capacity to define and reach goals is especially critical. It permits to assess team leaders' role in this task as well as level of support between collaborators.
- **Change:** As it is a critical factor it is expectable to identify which elements are more receptive to change and that present a bigger transformation capacity.

After analysing GSS Managers goals and developing all specific platform improvements to positively answer to all project requirements, we created a new social network in SNARE main installation and associated a manager responsible to manage social network and associated surveys.

As the number of social network members was not so high (22) we manually created the social entities in the system and did not sent any login information through collaborators' email. As we already identified relations that we wanted to infer, we created these relation types in the network, defining the correct directionality and their roles.

A GSS Manager created the survey together with the questions defined in the plan as the same time we helped him in the creation of the questions and answers. The correct question order was defined and the

manager itself used his account to first test the surveys. A deadline of fifteen days was defined to members to answer the survey and an invitation email was sent to the members alerting to the fact that they should answer a survey in a defined address, explaining project goals and what managers to infer from this specific experience. After that, an email with login details was sent.

During the following two weeks, together with the manager, we followed survey stats identifying who still had not answered the survey and alerting the manager for missing answers. We did not have the need for alerting forgotten users because manager did it personally, what was an advantage of testing a small group where members are easily contactable. We were able to track real time statistics during this phase watching statistical results about questions answered and drilling down individual answers.

After two weeks, the survey was closed and automatically converted to relation instances and properties. Final statistics results were available together with individual answers what allowed manager to deeply understand the answers before analysing the social network created.

6.1.4. Results and conclusions

This first survey construction allowed us to identify around thirteen problems: five programming bugs undetected, three requirements to improving some aspects related with user interface and user communication and five new reports about general suggestions and problems. We understood that the use of well visible alerts about tasks to be done in the homepage is a good way of obliging users to mandatory fill necessary data. We did not felt the need for remind users about survey finishing; neither the need for correcting user answers or asking detailed feedback about a specified question, but that was probably motivated by the number of persons tested.

The analysis of survey statistics results allowed, by itself, to understand some important details in ordering entities by their positive or negative importance in the network.

The survey conversion to a social network model was done without errors and in the end of the process we had identified 408 relationships with 7 different types, full detailed with context details and allowing drilling down to individual relationships between more connected social entities.

Performing social network analysis using SNARE Explorer allowed manager to understand, for each individual relation type, who are the most and less connected persons and who are the persons that form cliques in the network by similarity of connections. In appendix B are included reports for each relation type identified together with screenshots of SNARE Explorer analysis and some labels and hints that help to explain each graph obtained.

GSS Manager were able to confirm that most connected social entities about positive questions as trust, enterprise values identification, support, change motivators, are also the ones who have better annual evaluation in the organization. It was possible to identify in the social network groups composed by

persons of the same functional areas or connections between oldest peers and recently moved colleagues. As it would be expectable the most dense connection links are the ones maintained among people working in the same functional area.

This case study revealed also some of the reasons for higher performances, as well as some of the integration difficulties detected in some members. According to GSS Manager, It fully indicated some orientations between questioned vectors and individual and group performance. In a posterior analysis it was possible to identify the impact of these connections in the task execution performed by various groups.

6.2. POSI case study

A different case study was developed in order to evaluate SNARE capability to support and develop social network communities. We wanted to evaluate the easiness of user profile customization, together with user interaction on connecting among members and publishing content in private and public spaces. Starting from a social network composed by 342 members grouped in editions and with total freedom to interact among them we wanted to understand how this community would evolve and how people would be connected after some time of use.

6.2.1. Background

POSI (Pós-graduação em Sistemas de Informação) is a post-graduation degree lectured at Instituto Superior Técnico since 1998 and is oriented to professionals occupying higher positions in organizations developing activities related with Information systems. The degree lasts one year and is composed by several courses in the information system area, from the most technical point of view to a more high level business level. POSI has already ten past editions, frequented by 342 students and its coordinators felt the need to keep connections among these alumni and find a gap in what POSI continued to offer to former students after their graduation. Together with this fact, the truth is that most of the contacts of former students change during time, and links between students, professors and institution became weaker. POSI Alumni form an important network of knowledge and connections that can help former and current students in different situations. Therefore, it was natural that the idea to create a community of past students, supported by some networking platform and SNARE was chosen to develop and support this community.

6.2.2. Goals

The main goal behind this community creation was to enforce links between the school and among former students. It is a common option in different universities, schools and enterprises to have communities of former students grouped in alumni associations that after graduation can enjoy a set of services provided by the school, as current information about the degree, or subjects related to it, contact former colleagues, and access to job and business opportunities. However, even without this kind of associations, former classmates tend to connect among them when they find some known past colleague

in common social networking services, forming groups and keeping contact after some years without contact. Specialized websites were even developed to explore this business opportunity.

POSI Alumni community pretended to join past students in a platform, filled with current information kept at POSI database, but allowing each student to edit his own information. The project ambition was to develop a private social network, with similar behavior to popular social networking services and with common features. It could also support communities of practice where members can share their personal learning experiences.

Each member should have a personal profile that could be customized or extended by each one, and people should be able to browse the network, finding former classmates or colleagues and accessing their profile. Moreover, people should be able to interact in public and private spaces, and connect with everyone in the network being closer to the ones they personally know. Privacy and trust were fundamental variables in this project and people should not felt on being part of a case study or a university research application, so it was important to customize SNARE look and feel to adapt to POSI's requirements. Students should only understand that they are in a POSI personal alumni community and are not inserted in a common social networking service with a POSI network.

Although strong capabilities to encourage people interaction should be present, it was important that POSI Alumni work also as a manageable people directory, allowing its managers to identify missing or outdated information. It would be important that managers had ways to easily delete content to avoid abuse and entropy in public spaces.

Naturally, people mostly know the former colleagues from the same POSI edition so it was important to join people in edition groups that they could use to easily find past colleagues and interact in a more private space.

The ability to provide support to different surveys to one or more POSI editions, inquiring aspects about quality in courses, structure or logistic questions was also considered as one of the important SNARE features to be used. It could work as an important POSI management tool to assess current and past students opinion about some questions and improve pedagogic strategies.

Finally it would be interesting to perform social network analysis on the formed community to understand to whom people mostly connect. Hidden connections could be revealed like the ones between past colleagues from same enterprise, or common contexts before and after POSI graduation.

6.2.3. Planning and execution

Before the community creation several meetings were established, to discuss SNARE's capability to create communities and to understand which features POSI coordinators wanted to be available to alumni. We understood some concerns about lacking of support to groups in SNARE community concept.

An important detail required was a strong component to manage members by each edition, joining colleagues from same edition and allowing them to interact in a common space. Managing social entities by different editions would also facilitate the job of some POSI manager or operator.

The need for platform customizations as the adaption to POSI look and feel, and several questions about privacy made us to decide to create POSI alumni community in a separate installation deployed not only in a different address but using different databases and software instances. This option allowed us to customize application using POSI logo, and customize every application page as POSI coordinators asked without the risk to interfere with other social networks already present in SNARE.

A list with all data available with information about past students was supplied to us by POSI coordination. This list contained basic information about students like names, phones, emails, and edition and student numbers. This information was loaded by SNARExplorer that contains a powerful interface to import social entities lists in comma separated values files (.csv) and is able to directly export this information to SNARE Services to populate a social network. Unfortunately, the former students list did not have all information from students, inclusively some important contacts as a phone numbers or an email address. Information like name, phone and email was mapped in people's structural properties as the same time edition number was saved in a common dynamic property.

After all information was available in SNARE, a POSI operator was chosen to manage the social network in her starting phase. It should first create nine edition groups and to associate people with their groups, regarding the filled property "*edition*". This operator was responsible for contacting people that do not have a known email address in order to properly correct them before sending any login.

An online software management platform was used during this case study to improve communication with POSI operator, namely helping in problem and bugs resolution and in features or modifications requests. This proved to be a very good idea to manage the project, as helped to prioritize tasks and requests by order of arrival or importance.

Profiles and logins were generated to all social entities, and operator started to contact all students from each edition sending them an explanation about POSI alumni community and sending login details for each member account. As usual in SNARE, login in the system is done using the email and a generated password, so operator needed to contact students without email by phone, asking for a valid email account in order to provide them a login access.

During the first month, we understood the need for improving the interface to browse social entities, namely the need for introducing a powerful search engine to easily find persons by name, email or some known property. This feature helped POSI operator to discovery missing data in the database, or to easily find each social entity.

We also improved users' homepage, introducing direct links to current users' groups, helping them to easily find edition colleagues. We extended members' access to existing search features available to managers. These two features together, helped in increasing the number of connections between POSI former students.

6.2.4. Results and conclusions

We felt some difficulties in the beginning of this case study, derived by the short deadline to implement the community (around one week). Also, the need to install a new software instance totally independent from the used before did not helped at all. SNARE had not at that time any installation procedure to easily install a new instance with a different web address, email addresses and different databases. Community features had not been tested before this case study and their development time was relatively small.

Besides that, SNARE capabilities to create social communities were not planned at the beginning of the project and the connection with Web Comfort was not smooth. Web Comfort is not prepared to deal with social entities belonging to several groups, which of them with own properties that influence Web Comfort module behavior and access. It was not easy to create profiles that could be customized but at the same time should follow a general structure. Moreover, we needed to define roles to network and group members and correctly associate them with users when they join groups or networks. The option to create each profile as an independent WebComfort tab obliged us to correctly associate also roles with these tabs. We needed to define and extendedly test a process to maintain the structure and coherence between the template profile tab and all the other profile tabs created and customized by members, which was not easy, and at the beginning of this case study was not yet perfect.

We found some hard coded dependence between SNARE and its database or installation location that we needed to redefine and customize using option files. A script to correctly install new database instances and SNARE modules in new WebComfort instances was built and can be reused in future software installations.

This case study apart from allowed us to extendedly test existing features to community building using SNARE, inspired us to improve functionalities related with members search, group communication and general interaction.

After some time to experience user behavior and feedback, we were able to draw some conclusions, and watch some difficulties felt by POSI Operator to understand what was happening in the network, i.e. which users were using the network, how many connections were being made among them, which profiles and public spaces were being updated. By other side, we felt that members were having problems to find other persons in the network, especially the ones that were colleagues in the same year. Moreover the number of connections made among members was really low (5 connections): users had no advantage of being connected with other members. In popular social networking services people connect to each other to being able to see private profiles, or to easily find others in the future in the

platform. However, in POSI community all profiles were by default visible to everyone, so people did not felt the need to define relations among themselves.

First, we implemented a login control system to assess who and when was accessing the community, and registered his IP address. Therefore, the problem driven us to build a new feature that help users to keep tracking of their contacts updates. Directly in the homepage, users had a new module alerting to their lack of connections, and explaining the advantages of being connected with other members. When people are connected, this module shows the list of contact updates, i.e. who updated his profile, who are the ones that are now connected with other members, and which public spaces have been updated. The same feature was used to help managers to watch every members' updates. This improved their awareness of what is happening in the network in real time, and helped to find members with large activity and the ones that were not contributing.

Members started to connect among each others, not only edition colleagues, revealing new connections. POSI coordinators were even able of finding missing contacts of people with outdated contacts, by contacting edition and enterprise colleagues.

Last statistics (from September 6th) showed that already 132 alumni access POSI community, 66 of them are connected between each others. Currently 223 students have a login to access the system, but 119 students are still without connection. They do not have updated contact information to be informed and the trials to get their current contacts from other students were unfruitful.

Feedback received from POSI coordinators was positive and main goals were achieved. Also by alumni side we felt that this project helped them to find older colleagues, and use the community to establish important connections. Some feedback showed us some hints to drive future work and POSI community management.

However, it is still early to understand how POSI community will work in the future. It is important to maintain activity in the network to avoid that the platform work as a simple people directory. Future will show how alumni will use the community and what kind of content will the members publish in public and private spaces. Probably, new types of relations and other entities as professors, operational staff, coordination and technical support staff will be added to the network, opening new challenges and opportunities.

Moreover, it is natural that SNARE community functionalities will be extended in the future: we understood already the need for improving public and private spaces, namely group and network bulletin boards: they represent popular ways of discuss problems, posting content and allowing everyone to easily contribute about POSI subjects or professional ideas. We need also to improve user interaction and options to define privacy options and general configurations to allow members to customize personal experience using the community. It is important that POSI alumni community brings more that the joint of

all student contacts in order to be different from others popular social networking services and keeps being used during time. An important addition can be done if current students would be added to the system, because they are the ones that most interact with POSI staff and can use knowledge and experience from former colleagues.

More case studies like this one will be developed using SNARE what can present new requirements and challenges that SNARE do not support yet. Apart from that, as already explained, Social Networking Services are developing at an incredible speed. It is natural that new features and modules will be present also in SNARE as long as developers and members face the need for this kind of technologies.

7. Conclusions

Real or virtual social networks are present in organizations' daily life and its analysis can enable managers to assess important hidden information and to reveal how people communicate in organizations, groups and teams. Moreover, Social Network Analysis can improve existing processes or be used to predict future interactions upon changes.

Understanding how Social Networks are constituted and which links exist among actors is far from being easy. Relations are most of the times, different from the ones expressed in organizational charts, relationships evolve during time, and many interactions are not done communicating face by face, but using collaborative tools, interactive chats or even social networking services. Social Network built using every member's contribution is important, and this process is only possible by the integration of different information sources and automatic data gathering.

SNARE proposed to join capabilities of social network discovery and extraction, management, analysis and reuses these concepts to build active communities that can be used in groups or organizations. An application core is defined to handle fundamental concepts related to social networks and different services and applications are developed to address different requirements and functionality scope.

In this chapter we present what we think that are SNARE's main contributions in this field of study, analyzing its use in different contexts, and presenting some hints of what we believe will be its future directions.

7.1. Main contributions

We believe that the service oriented architecture defined the project success as it enabled the extension of our primary concept to a broad set of ideas that were developed during this master thesis. The definition of a common social network model used to represent social networks in different contexts helped this extension as it reused most of the functionality already present adding increased value with new features and possibilities.

SNARE introduced the notion of a platform that is able of gathering social networks from different sources by automatic extraction or organizational surveying and performs common analysis on the built networks.

In this thesis, we implemented SNARELib, a code library developed in C# that uses a SQL database to handle all fundamental concepts related to social networks, as social entities, relation types and instances, roles and properties. We chose to follow a SOA approach developing a set of web services named SNAREServices that deal with this code library, centralizing application functionality and behavior and that is used by different applications.

We developed WebSNARE a web application that provides a front-end interface to SNAREServices and that is able to manage multiple social networks, and its social entities, define and instantiate relations and roles, and extend these entities with dynamic properties. Therefore, we focused in the extension of SNARE to discover social networking by the analysis of surveys directed to all social entities present in the social network. We extended SNARE social network model to handle the definition of surveys with questions and answers from where relationships or properties could be extracted. Question model supports different question types from simple open questions to questions with complex hierarchical answers. Moreover, we developed a conversion process to directly convert answers to relationships and personal properties. These new features were developed using a new web service that continues to use SNARELib. New interfaces and modules were developed in WebSNARE to handle these new features and several questions and surveys templates can be reused in the different social networks.

Finally we developed a new set of services to manage communities based in SNARE social networks. We improved general application interface and interactions to provide a more user-friendly behavior together with a communication mechanism that allows members to easily find each other and contact among themselves in public and private spaces. SNARE Communities work as usual networks in social networking services providing personal profiles able of being customized, with private and personal spaces where users can interact, and with improved communication features as personal messages, requests and alerts. SNAREExplorer a tool that is used to perform social network analysis, also uses SNAREServices to import and export data from social networks.

SNARE was used to survey a management group at Vodafone Portugal, helping in gaining insight about questions as general trust, support, and cultural values. A survey based in organizational engineering literature was directed to 22 collaborators. Their answers permitted to build a social network that was analyzed using SNAREExplorer.

SNARE was also used to build a community of former students of a postgraduate program about information's systems at IST, named POSI. This project allowed us to test with more than hundred users the capabilities present to create and manage communities, together with the possibility of feeling users' reaction and receive feedback of what could be improved. Together with POSI operator we understood the need of improving user awareness of others' activities so we defined modules to increase communication and activity inside the network what led to more connected and active users. However we are not still fully satisfied with results obtained so is normal that in the future this aspect would suffer deeper improvements.

Research work developed during this thesis led to the publishing of a full chapter about social network tools and services in a book named "*Handbook of Research on Social Dimensions of Semantic Technologies and Web Services*".

7.2. Future work

Work developed in SNAREServices allows future utilizations in total different contexts from the ones initially planned. However, current features need also to be improved and completed.

Starting from SNARE core concepts it is important to improve social network domains and contexts handling to allow analysis of specific relation types and grouped relations by context.

In organizational surveys several suggestions can be adapted in the future. They were not implemented by lack of time or because they were less prioritary then others implemented. Surveys can be directed to specific members or category of members instead of being available to everyone. In this way, several customized surveys could be present to different actors allowing a deeper understanding of different departments and teams. Moreover, SNARE surveys modules are not prepared to deal with social networks with hundred of entities and these modules should adapt to this kind of information requirements containing customized interfaces to different situations. Inferences can also be improved, namely the capability to infer other persons' properties, and not only the ones from who is answering the survey.

Communities present several issues that should be improved: it is fundamental to redesign public and private spaces, and to build network and group bulletin boards moderated by managers or operators where members can interact and discuss subjects relevant to all. It is important to implement a customized notification system that alerts members to current discussions and to encourage participation with defined goals. We feel also the need for improving privacy and customization options in order to allow members to redefine in an easier way their notifications and updates options and their profile visibility to other members.

It is expectable that SNARE continues to be used throughout other projects and case studies, namely when its ETL component is developed. SNARE could connect to other information sources and social networks gathered could be modified and analyzed using other components. A new study in Vodafone Portugal is currently being prepared and will be directed to all collaborators in order to identify organizations issues that were already revealed during the first case study. POSI Alumni community will continue to work as an active community where former students can find old classmates and exchange knowledge and expertise about past and current questions.

8. References

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Appendix A - SNARE Database Structure

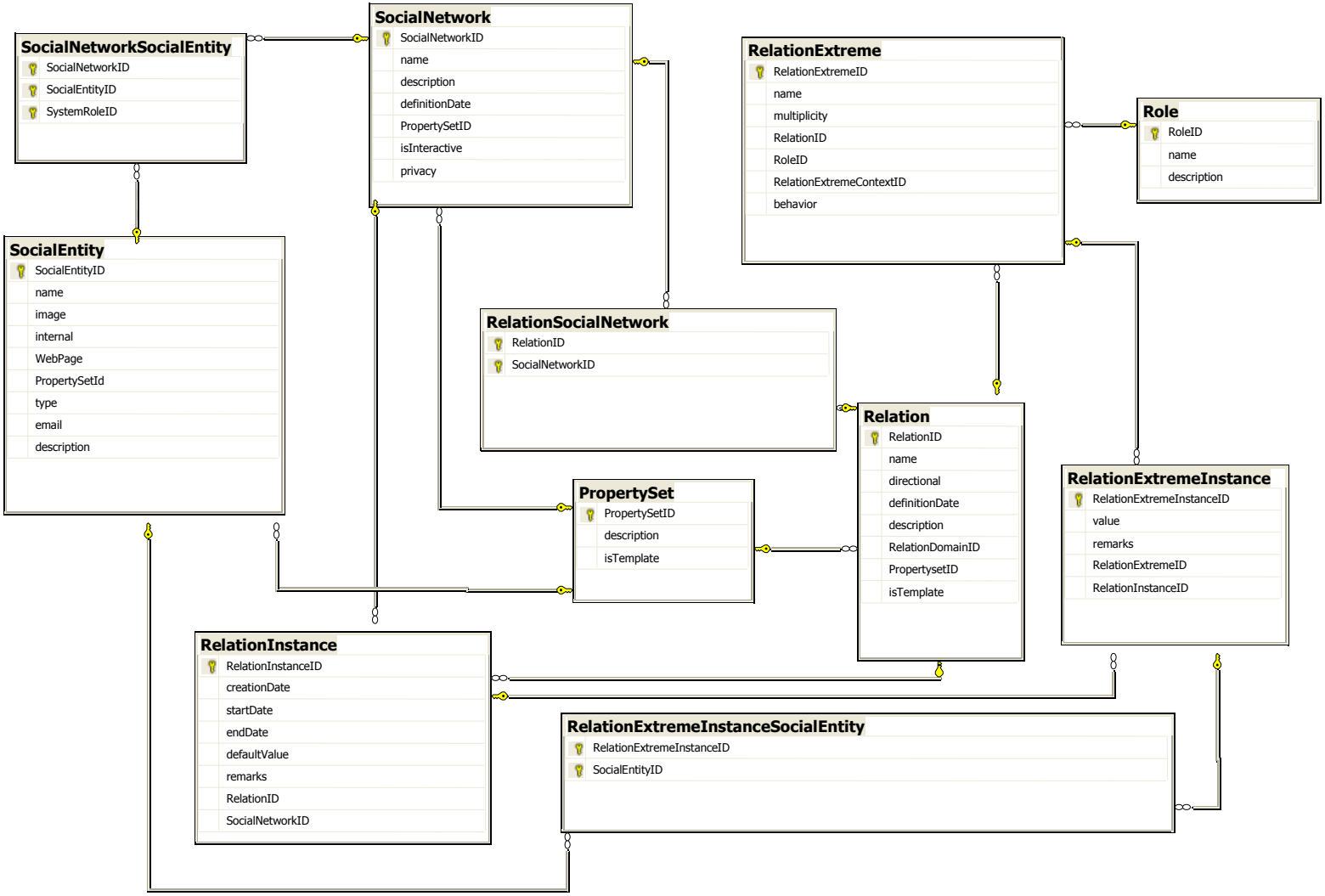


Figure 44 - General Database Diagram

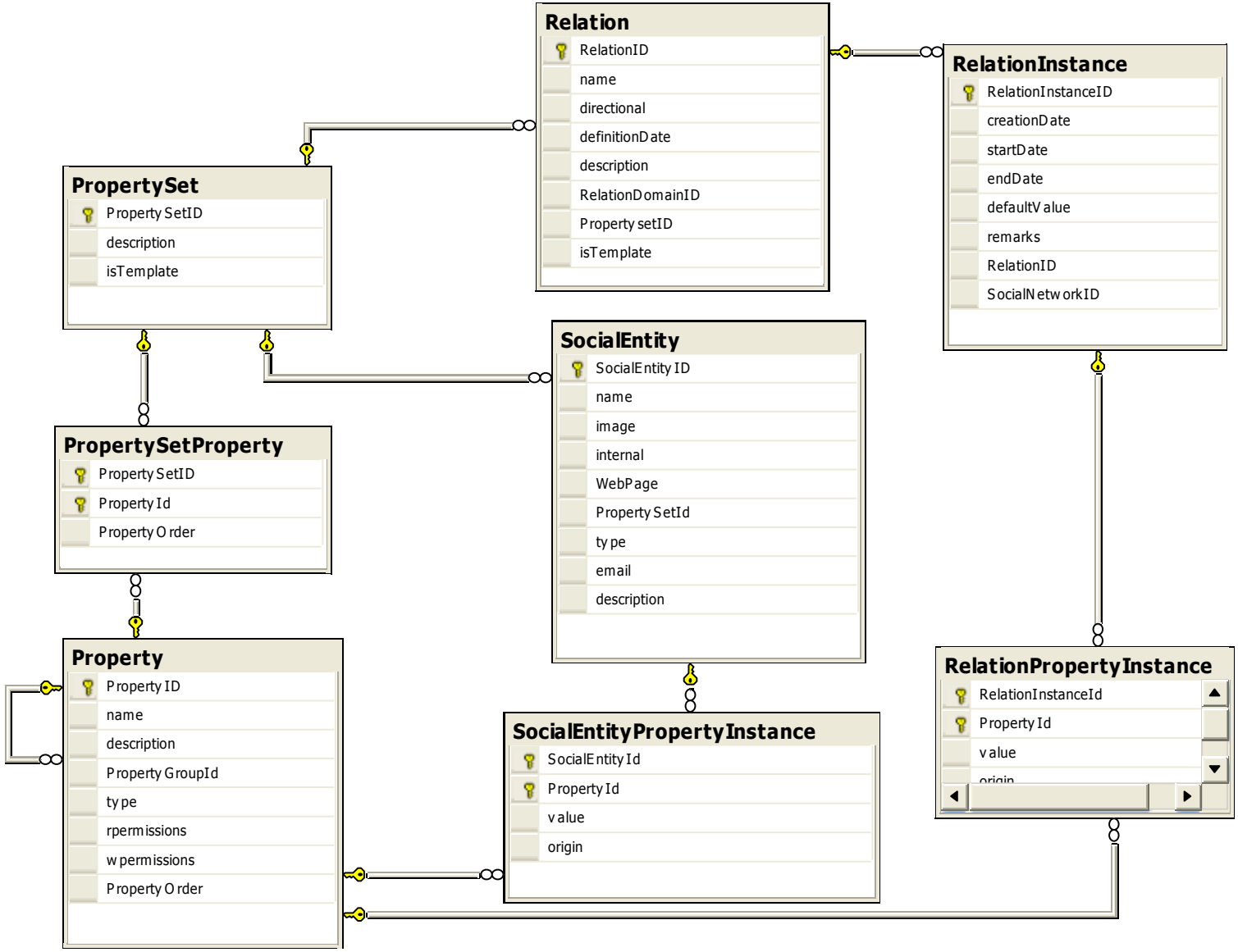


Figure 45 - Properties Diagram

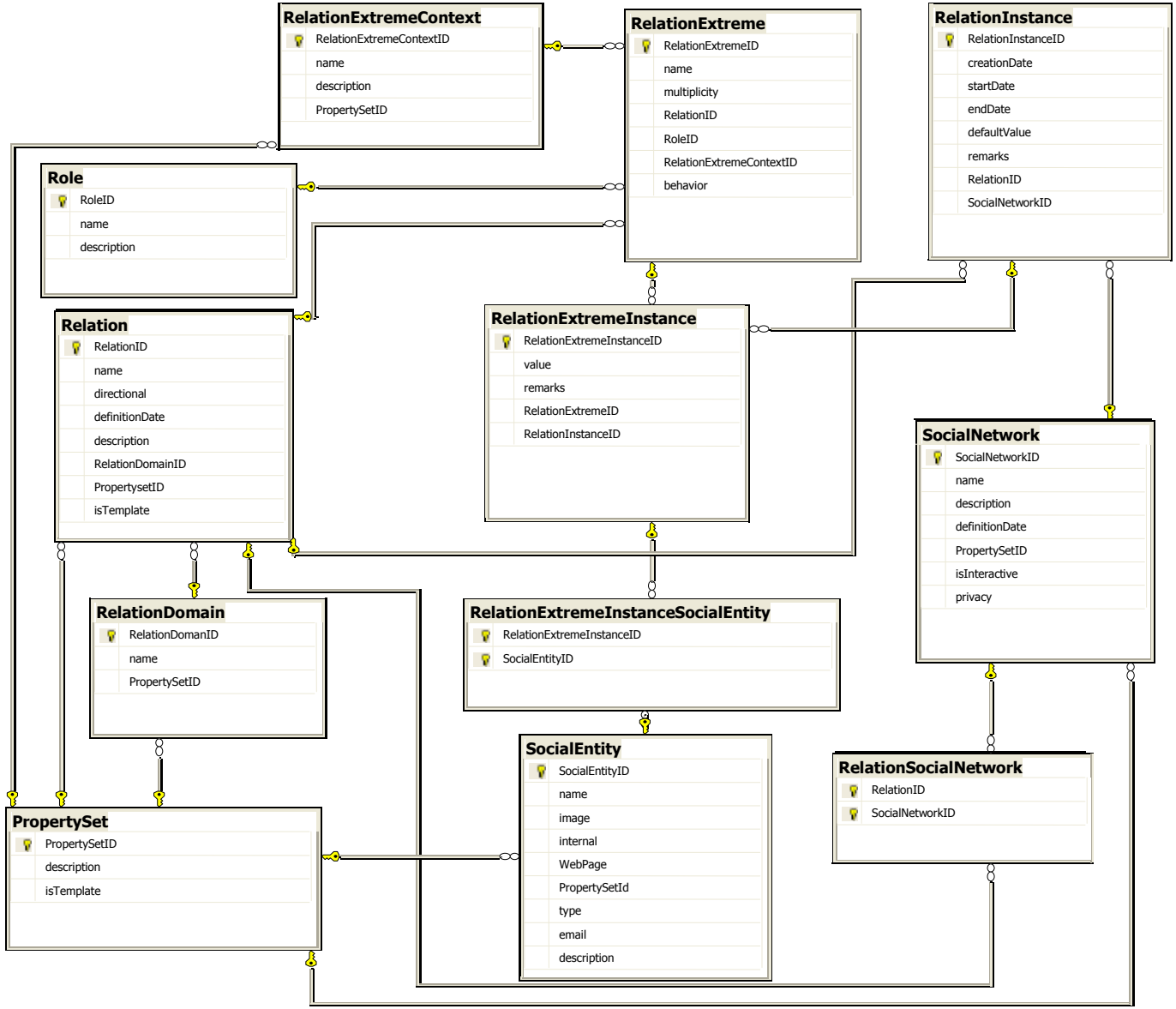


Figure 46 - Relations Diagram

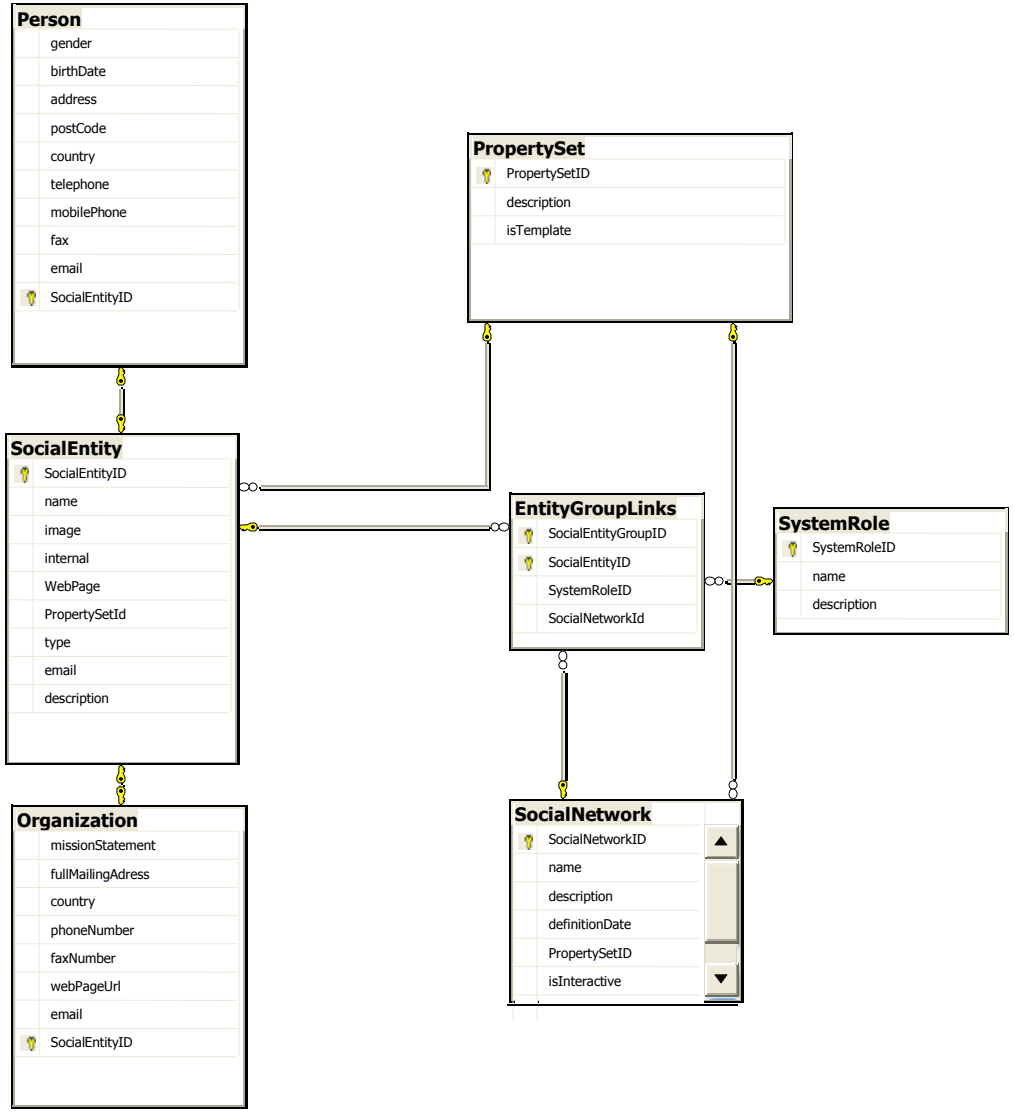


Figure 47 - Social Entities Diagram

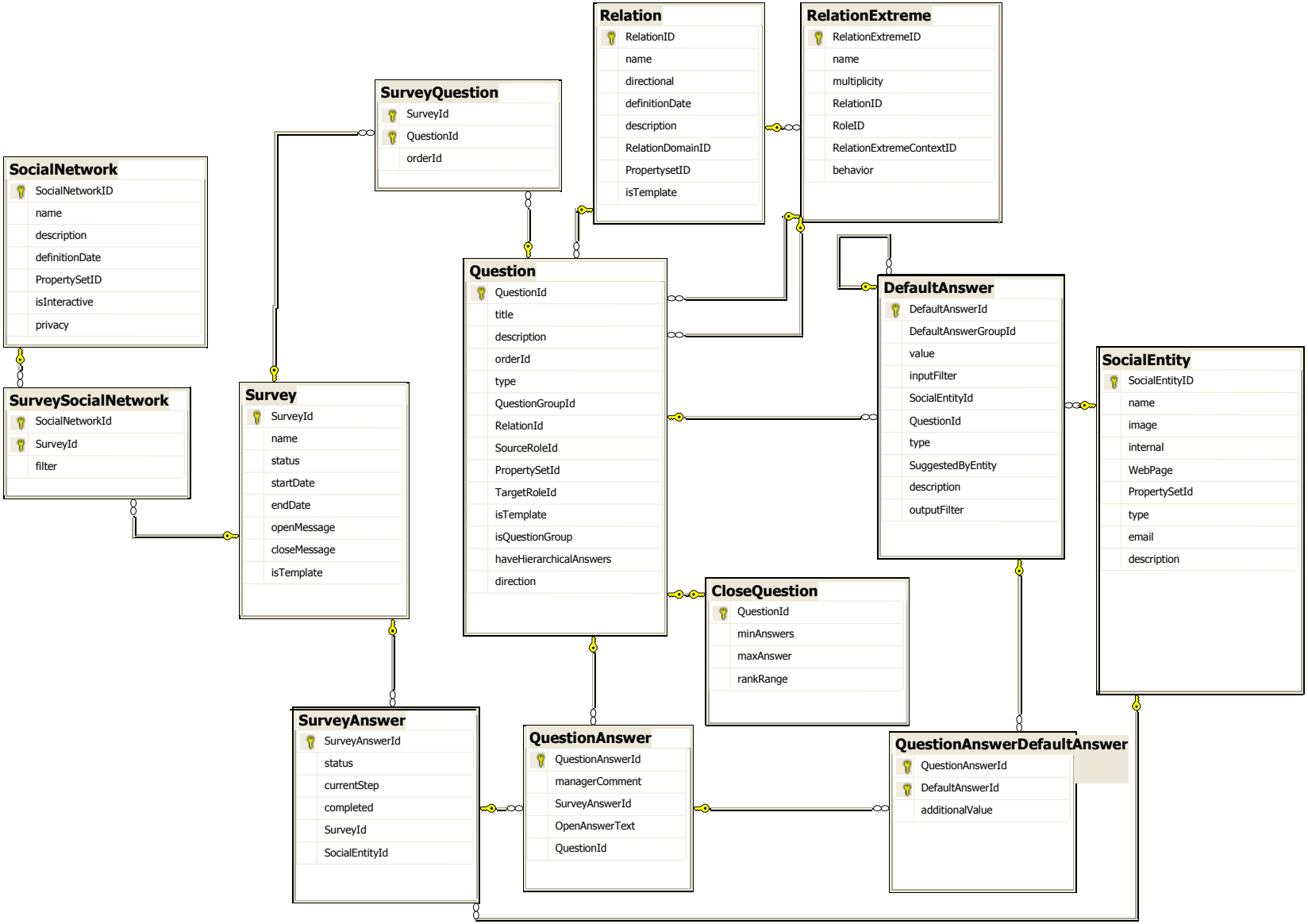


Figure 48 - Surveys Diagram

Appendix B – Vodafone Portugal Case Study

In this appendix is presented the survey applied in case study Vodafone Portugal, together with its results and some hints and curiosities that can explain it. This is the first survey that was applied in a single department of Vodafone Portugal (GSS Survey), composed by 22 collaborators, while in the future a second one will be directed to all Vodafone collaborators.

Survey Structure

A group of eleven questions was defined to infer relationships with different directionalities, properties or relationships with associated properties. In this set of questions were defined questions with open answer, with a defined set of answers but allowing users to create new answers, directly linked with social entities, together with group questions and hierarchical answers.

Which are the five persons in whom you trust more extensively in GSS?	
Question Type	**Closed answer:** All GSS members are possible answers.
Inference:	**Relationship:** Trust **Who is answering:** The person who trusts. **Answers:** The persons in which the other trust.
Possible Answers:	5 (Maximum and minimum)
Directional:	✓

Which are the persons with who you most identify yourself in GSS?	
Question Type	**Closed answer:** All GSS members are possible answers.
Inference:	**Relationship:** Identification **Who is answering:** The person who feels identified. **Answers:** The persons others identify as an example.
Directional:	✓

Which are the persons that support you during task realization?	
Question Type	**Closed answer:** All GSS members are possible answers.
Inference:	**Relationship:** Support **Who is answering:** The person who feels supported. **Answers:** The persons others identify as a support.
Directional:	✓

Which are the persons that contribute to your goals realization?	
Question Type	**Closed answer:** All GSS members are possible answers.
Inference:	**Relationship:** Goal realization contribution. **Who is answering:** The person who feel the others as important to her goals realization. **Answers:** The persons who help to goal realization.
Directional:	✓

Only by curiosity what is your football club?	
Question Type	**Expandable answer:** SL Benfica, Sporting CP, FC Porto, Belenenses are default possible answers.
Inference:	**Social Entity Property:** Footbal Club

For each one of the following contexts, please identify which are the persons who represent bigger opposition to changes. You can supply a new context.	
Question Type	**Hierarchical question with expandable answer:**Configuration and support are two defined default answers and all social entities are represented as sub answers.
Inference:	**Relation:**Opposition to change **Who is answering:** The one who things the others are opponents to change **Answers:** Opponents to change. **Relation Instance property:** Context
Directional:	✓

For each one of the following contexts, please identify which most contribute to changes. You can supply a new context.	
Question Type	**Hierarchical question with expandable answer:** Configuration and support are two default answers and all social entities are sub answers.
Inference:	**Relation:**Contribution to change **Who is answering:** The one who things the others are change motivators **Answers:** Motivators to change. **Relation Instance property:** Context
Directional:	✓

Who is the person that best represent Vodafone values inside GSS?	
Question Type	**Closed answer:** All GSS members are possible answers.
Inference:	**Relation:**Vodafone values identification. **Who is answering:** The one who things the others are good Vodafone values keepers. **Answers:** Members identified as good Vodafone values representations'.
Directional:	✓

The next question group pretends to infer your self evaluation regarding a defined set of vectors	
Question Type	Group question.
Inference:	None

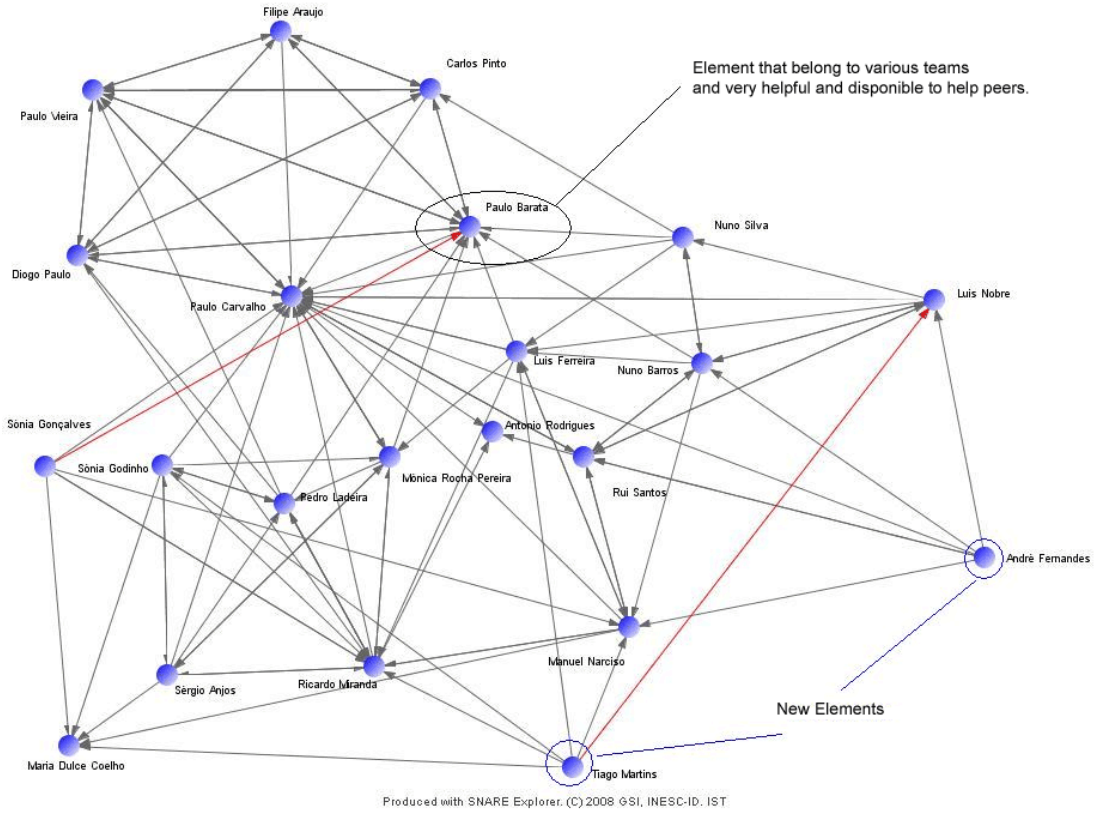
Please rank your self evaluation regarding the following aspects: trust, Vodafone values identification, motivation and satisfaction from 1 to 10.	
Question Type	**Rank answer:**trust, Vodafone values identification, motivation and satisfaction are defined answers.
Inference:	**Social entity properties:**trust, Vodafone values identification, motivation and satisfaction

Finally, please feel free to insert a brief comment where you can provide more feedback or some explanation to your answers.	
Question Type	Open question
Inference:	None. Manager can read individual answers and complete His evaluation.

Survey Results

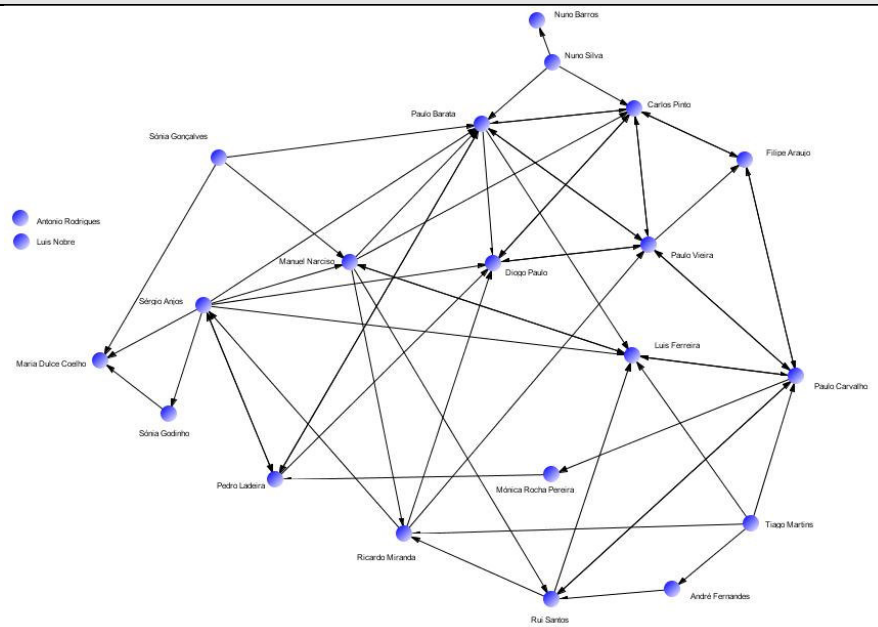
This section present each question results and present some hints and conclusion refered by GSS Manager in every question.

Which are the five persons in whom you trust more extensively in GSS?



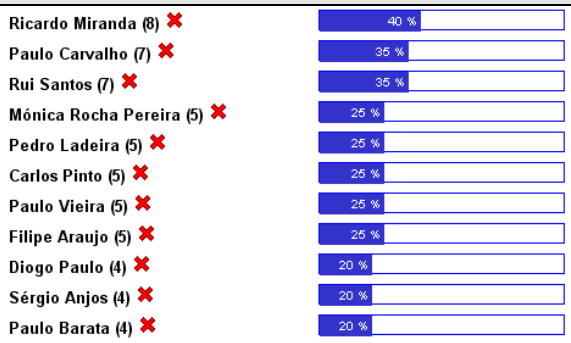
In this graph we can understand that trust levels are higher inside functional areas and between older peers.

Which are the persons with who you most identify yourself in GSS?



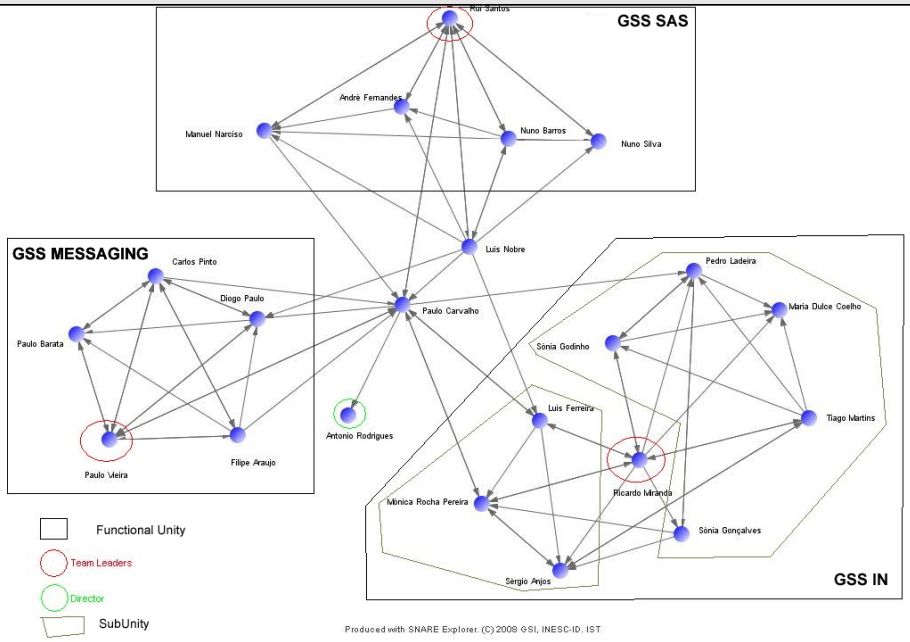
An interesting conclusion from this result analysis is to note that managers are not specially central in the graph, what can show some lack of identification with group leaders.

Which are the persons that support you during task realization?



As expected managers appear as best supporters to task realization. Moreover, inside functional areas support is greater that in general network

Which are the persons that contribute to your goals realization?



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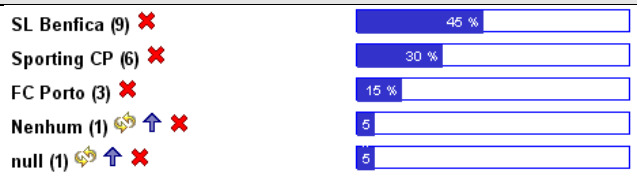
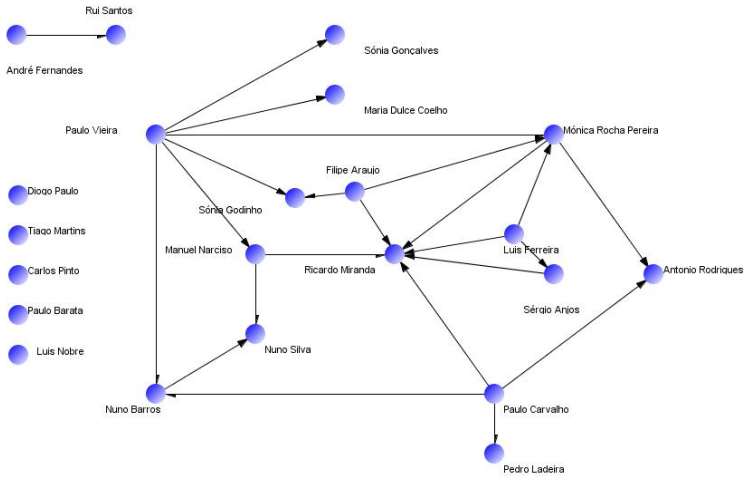
Functional areas are perfectly identifiable and as supposed Managers represent central connections in the network. Recently changes in GSS IN are visible.

Only by curiosity what is your football club?



Results approach club dominance usually presented in statistics in Portugal.

For each one of the following contexts, please identify which are the persons who represent bigger opposition to changes. You can supply a new context.



It is interesting to understand that higher hierarchical positions represent bigger opposition to changes that lower hierarchical positioned collaborators. In this image is not possible to understand in which contexts there are more opposition to changes.

Who is the person that best represent Vodafone values inside GSS?

Paulo Carvalho (7) ✖	37 %
Ricardo Miranda (4) ✖	21 %
Paulo Vieira (3) ✖	16 %
Carlos Pinto (2) ✖	11
Rui Santos (1) ✖	5
Pedro Ladeira (1) ✖	5
Luis Ferreira (1) ✖	5

Please rank your self evaluation regarding the following aspects: trust, satisfaction, and motivation and Vodafone values identification from 1 to 10.

Confiança (19) ✖	7/10
Satisfação (19) ✖	6/10
Motivação (19) ✖	7/10
Identificação com Valores Vodafone (19) ✖	7/10

Finally, please feel free to insert a brief comment where you can provide more feedback or some explanation to your answers.

Members used this answer to generally comment aspects about the survey or to clarify some of their answers and results.