UNIVERSITY OF GOTHENBURG

An Exploratory Study of Free / Libre / Open Source Software Organizations

Master of Science Thesis in Software Engineering and Management

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Acknowledgements

Abstract

Growing research on the adoption of a FLOSS ecosystem among novice adopters have been seen during the last decade. However, due to the increasing rise of novice adopters such as FLOSS organizations, firms, individual developers, users and researchers who are wishing to adopt a FLOSS ecosystem, it is important to know how different FLOSS components (i.e. FLOSS organizations and projects) within a FLOSS ecosystem evolve and what are the core reasons/factors that influences their evolution. In this research study, we will use Theoretical Saturation Grounded Theory approach to collect and analyze all relevant data in order to determine, some of the key attributes of different FLOSS organizations,organizations roles in FLOSS projects and furthermore, using developer multi-homing concept, we will be able to determine the relationship among FLOSS organizations. Our findings will be useful to guide the future novice adopters with an understanding of a FLOSS organization, FLOSS organizations role in FLOSS projects and some of the key reasons that influences the relationships among FLOSS organizations from multi-homing perspective, before they learn (or) join in an existing ecosystem (or) build their own FLOSS ecosystem.

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Abbreviations

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Abbreviations

FLOSS	Free/Libre Open Source Software
TSGT	Theoretical Saturation Grounded Theory
Govt	Government
Educ	Education
S/W	Software
DB	Database
Projs	Projects
Org	Organization
Orgs	Organizations
BOD	Board of Directors
AB	Advisory Board
FSLP	Free Software License Projects
CSLP	Commercial Software License Projects
FM	Free Membership
NM	No Membership
PM	Paid Membership
IP	Intellectual Property
PMC	Project Management Committee
CLA	Contributors License Agreement
ASF	Apache Software Foundation
OWASP	Open Web Application Security Project
NIFGOSS	North Initiative for Geospatial Open Source Software
OSGeo	The Open Source Geospatial Foundation
MPIFPR	Max Planck Institute for Polymer Research
CSC	Computer Sciences Corporation

SMC	Swathanthra Malayalam Computing
LRDE	EPITA Research and Development Laboratory
TV-LES	TimVideos.us - Live Event Streaming
BBOSP	BlackBerry Open Source Projects
LEAP	LEAP Encryption Access Project
GNN	German Neuroinformatics Node
ASI	Adobe Systems Incorporated
GPA	Grid Protection Alliance
TIETF	The Internet Engineering Task Force
TSCA	Tiki Software Community Association
No	Number
N/A	Not Available or Not Applicable

1.Introduction

Free/Libre Open Source Software (FLOSS) development is a new way of developing software, a process that has gained strong presence within academics, industries and government sectors [1-3]. FLOSS development is a community driven process unlike closed software development process that is driven by the firms. A common assumption is that, there are significant benefits by using FLOSS development model to build the software [4]. Organizations and firms emphasize cost saving and high quality software as a reason for entering and contributing to FLOSS development, while individual developers from different geographical locations emphasize pride, ambition [5] and socially-based motivations for entering and contributing to FLOSS development in a virtual community which is called as FLOSS community [6] [7] [8].

"Open Source production has shown us that world-class software, like Linux and Mozilla, can be created with neither the bureaucratic structure of the firm nor the incentives of the marketplace as we have known them"- Howard Rheingold [9].

At present, FLOSS is having a huge impact on the software industry and its development processes. Numerous proprietary software products developed in firms contain at least a bit of FLOSS components. Some proprietary products are completely FLOSS based softwares [10]. FLOSS holds major market share in some of the markets [11]. According to [12], there is an exponential growth of open source organizations, firms and individual developers who are wishing to adopt the FLOSS platform in order to develop the software. However, due to the constant rise of different FLOSS components within the FLOSS platform, the understanding of relationships among these different FLOSS components tend to be one of the vital challenges for the novice adopters such as firms, organizations, developers and researchers within the FLOSS platform.

Future novice adopters have the possibility to modify the open source software to suit their business needs. Novice adopters adopt FLOSS because of technological, economical (or) social reasons. Most important driver of FLOSS adoption (both for individuals and organizations) is cost. Apart from cost factor, perceived reliability, compatibility with current technologies and skills in use can also drive the adoption of FLOSS components. Support from vendors like IBM can also make most FLOSS organizations and firms comfortable in adopting the FLOSS components. But, some organizations might rely on their own skills and free online support available from open source communities to build their own FLOSS products. Credibility is also earned by individuals, institutions and firms through participation [13] [14].

Our research study is primarily interested in addressing the understanding of different FLOSS organizations, the possible relationships among FLOSS organizations and the relationships

between FLOSS organizations and projects. This is because, currently little is known about the evolution of different FLOSS components within the FLOSS platform. Firms, organizations and developers wish to learn, join (or) build the FLOSS components such as FLOSS organizations, projects and communities. In order for them to perform these tasks, they might need information about, i) the different types of FLOSS organizations that currently exists in the FLOSS platform, ii) what are the organization's characteristics (i.e. attributes), iii) How organization's host (or) manage its foundation projects and, iv) what type of support and services are given by the organizations to its foundation projects. In addition to these information, they might also need other essential information such as, i) How different organizations do have relationships through project multi-homing, where a FLOSS project might be hosted (or) claimed by more than one FLOSS organization, ii) How different organizations do have relationships through developer multi-homing, where an individual developer contributes to projects from different FLOSS organizations [32], iii) How different FLOSS organizations can collaborate with each other to form a relationship and, what are the core reasons behind those formed relationships. By knowing all these information, the future novice adopters can get a clear understanding of different FLOSS organizations, organization's role in FLOSS projects and relationships among different FLOSS organizations. Novice adopters will also be able to create their own FLOSS components (or) join/adopt in an existing FLOSS components through these essential information.

To sum up, In order to identify the relationships among different FLOSS components within the FLOSS platform, our study will explore to find out, 1) different FLOSS organization's attributes, 2) FLOSS organization's role in FLOSS projects and, 3) the relationships among FLOSS organizations through project multi-homing, where we will investigate whether a FLOSS project is hosted by two different FLOSS organizations and as well as, 4) the relationships among FLOSS organizations through developer multi-homing, where we will investigate whether a single developer is contributing to two projects from different FLOSS organizations. Finally, we will find out the core reasons behind those relationships among different FLOSS organizations.

1.1 Problem Statement

Presently, there is an exponential growth of FLOSS organizations, firms and developers who are wishing to adopt the FLOSS component. However, understanding of relationships among different FLOSS organizations and between a FLOSS organization and projects tend to be a vital challenge for the future novice adopters who wish to learn about different FLOSS component (or) join an existing FLOSS component (or) build their own FLOSS component. In addition to this, most of the existing body of knowledge within the FLOSS area are based on the evolution of FLOSS projects and contributors [15] [16] [17] [18], while there is a lack of research on the evolution of FLOSS organizations. Therefore, our proposed research on the problem should be undertaken to determine how FLOSS organizations and projects

evolve, what are the relationships among different FLOSS components and some of the key reasons influencing these relationships and evolution within the FLOSS platform.

1.2 Purpose

The purpose of this research study is to explore, 1) different FLOSS organizations, 2) FLOSS organization's role in FLOSS projects and, 3) the relationships among FLOSS organizations through project and developer multi-homing concept. Our findings will be useful to guide the future novice adopters with an understanding of different FLOSS organizations, FLOSS organizations role in FLOSS projects and the relationships among FLOSS organizations within the FLOSS platform, before they can learn (or) join an existing FLOSS components (or) build their own FLOSS components.

1.3 Research Questions

RQ1: What defines a FLOSS organization?

The aim of this research goal is to explore and identify different FLOSS organization's key attributes and values. The key attributes and values will be able to define a FLOSS organization through a developed taxonomy.

RQ2: What role do organizations have in FLOSS projects?

The aim of this research goal is to explore and identify some of the key roles a FLOSS organization could have on its foundation projects. These key roles will be able to show us, what kind of role a FLOSS organization can play to hosts its foundation projects.

RQ3: What is the extent of multi-homing in FLOSS organizations?

The aim of this research goal is to identify whether FLOSS organizations have relationships from project and developer multi-homing perspective. After identifying the relationships between two different FLOSS organizations, we will construct the relationships network and then, we will investigate the core reasons behind the relationships among FLOSS organizations.

1.4 Thesis outline

This report is organized as follows:

Section 2 describes the background and related research works,

Section 3 introduces the methodology used to conduct this research study,

Section 4 covers the results analysis,

Section 5 covers the discussion of the results and threats to validity of this study and finally in Section 6, conclusion and the possible future research work discussed are presented.

2. Background and Related work

2.1 Background

2.1.1 FLOSS

Free/Libre Open Source Software (FLOSS) in general can be defined as a computer software that allows the developers to modify the available source code under a copyright license [19]. FLOSS is increasingly gaining popularity in recent years because, it represents a software development model that has created a new revolutionary way of developing the software [18]. FLOSS development has gained much attention from industries, research communities and practitioners [20] [21]. Developers from different parts of the world can access the available source code without any restrictions. The developers can also view, read, modify and redistribute the available source code [22]. FLOSS is one of the better solutions available in the current market to reduce the cost and improve the quality of the software [23]. In general, developers contribute to FLOSS because, they have permission to make copies of the software, distribute those softwares, have access to the source code and they also have permission to make the improvements to the software. A developer can save lots of time and energy by incorporating FLOSS into a FLOSS project [23]. FLOSS however differs from proprietary software since the software released under proprietary ownership comes along with a license. A owned software is normally a proprietary software that is released under a restricted license agreement [24].

2.1.2 FLOSS Projects

FLOSS Projects are also called as an open source software projects. They are distinct from proprietary software projects since, proprietary softwares are released under a license agreement. FLOSS projects are created by a community of developers and they have the rights to make changes to the source code repository. In a FLOSS project, community of developers share a common interest in the project and they collaborate in a social and professional network to accomplish a task that involves many specific activities and to establish a strong FLOSS platform [25] [11]. FLOSS projects growth is usually dependent on the growth of the open source platform with developers and users [26]. These projects in general are developed through collaboration of different developers regardless of their geographical locations (or) personal background [27]. These FLOSS projects are considered as successful only if they are developed by hundreds (or) even thousands of developers [28]. Developers contribution within the open source platform not only drives the project growth, but it also promotes the role of these contributing developers within the FLOSS platform [29]. Most of the FLOSS projects are hosted by FLOSS organizations. FLOSS projects under a FLOSS organization depends on the governance structure and communication processes within the foundation [15].

Some FLOSS projects such as Linux Kernel, Apache and PHP are responsible for most of the FLOSS movement's success. A niche FLOSS project that uses the same programming language (or) operating system could attract more developers to contribute to their project. In order to sustain, FLOSS projects needs to retain its existing active developers and users to attract more new users [15]. If a FLOSS project is abandoned within the open source platform, the users of the project might have to face significant challenges of not getting necessary support and services [15]. Some of the FLOSS projects like Apache is governed by the Project Management Committee (PMC) who are responsible to make critical decisions regarding the changes to the source code and they grant access to the developers through a voting system. Some projects have an acceptance policy for accepting developers into the developer's circle [10].

2.1.3 FLOSS Organization

A FLOSS organization is generally referred to as an FLOSS foundation that constitutes an association of people and firms to develop the community open source software. Examples of FLOSS organizations are ASF, Linux Foundation, Eclipse Foundation etc [30]. Some of the FLOSS platforms start a FLOSS foundation to protect their software intellectual property and to carry out contractual agreements [31]. In general, a FLOSS organization's role is to serve as the steward of its foundation projects and it ensures their long-term survival. It also provides financial and legal support to its projects. A FLOSS organization takes responsibilities to organize project communities, management and clarification of the intellectual property rights. They are also responsible for active marketing of the software, running all back-office processes and set strategic directions for the software [30]. FLOSS organizations within the open source platform have many developers who contributes to their foundation projects.

2.1.4 Multi-homing in FLOSS

In the context of mobile software platforms, Multi-homing is a strategy where a developer publishes products and services on multiple platforms such as Apple App Store, Google Play, Windows Phone MarketPlace etc [33]. Since the number of users are high in multiple platforms, Multi-homing improves the popularity of the code and product, which is an advantage for the developers [32] [33].

Since our study is based on the context of FLOSS organizations, we will be using developer multi-homing concept to identify the relationships among FLOSS organizations and to investigate, whether a committer from one FLOSS organization is contributing to the projects of another FLOSS organization. Similarly, we will also identify the relationships through project multi-homing in order to investigate whether, a single FLOSS project is hosted under two different FLOSS organizations.

2.2 Related work

Due to economical, social and technological importance of FLOSS components, it is important to know, what are the core reasons that influences the development of these FLOSS components within the FLOSS platform. By knowing these facts, one will be able to predict the directions of how different FLOSS components within the FLOSS platform would evolve in the future. Similar research studies to ours has been published in [30] [31] [34] [35] and [36].

The study by Riehle [30] demonstrates some of the FLOSS organization's responsibilities to manage and ensure long-term survival of its foundation projects . FLOSS projects primarily sustain through financial support and legal assurance provided by the foundation. This makes the FLOSS projects to be less dependent on the volunteers who initially started the project. In addition to this, FLOSS foundation has other various responsibilities to host (or) manage its projects. Responsibilities include, i) organizing its community project ii) actively marketing its projects iii) Managing IP rights iv) Setting strategic directions for the projects etc; This study shows us that, a foundation can be open to everyone but, a membership fee might be required to join a foundation. Anyone who wants to contribute to the foundation project must sign the contributor agreement. In contrast to this study, our research study mainly focuses on the organizations role in FLOSS projects. FLOSS organizations play many different roles in order to host its foundation projects. We will explore different FLOSS organizations and will find out the organization's characteristics and the different roles a FLOSS organization could impose on its foundation projects.

The study by Xie [31] describes about firms involvement and governance within the open source platform as well as, the source of revenue generated within the FLOSS foundation. Through this paper, we notice that some open source platform establish FLOSS organization's to protect their platform IP rights. In turn, FLOSS organizations help open source platforms to build their long-term goals. Firms gets involved in order to make an influence in the foundation. Foundations gain financial assistance through donors and taxes. This study also describes about the governance structure within the foundation. In contrast to this study, our research study will identify some of the FLOSS organization's attributes such as governance structure, licensing policy and sustainability factors such as donors, partners etc;

The study by Timo and Jyke [34] shows us that, a small number of contributors (i.e. developers) and corporates (i.e.firms) has influence in the development of linux kernel community. This study demonstrates how contributors from different corporates contribute to the Linux Kernel community. Through this study, we have noticed that, the most influential firms have a huge impact to the evolution of Linux Kernel community. This study also highlights that, a small group of core contributors are the influential persons in the Linux Kernel community. Finally, this study describes about the various aspects of people involved

and the role of firms in the Linux Kernel community development. However, in our research study, we will explore different FLOSS organizations. Then, we will identify the relationships among FLOSS organizations through project and developer multi-homing concept and then, we will determine the key reasons that could influence the relationships among FLOSS organizations.

The study by Hammouda and Syeed [35] shows us that, how the challenge of tracking resembling relationships (i.e.similarity factors) between FLOSS projects has been addressed. This study demonstrates about the developer's contribution to several FLOSS projects, simultaneously (or) at different times in order to determine the relationships between such projects. Through this study we can also notice that, the more shared developer's two FLOSS projects have, the more likely these projects resemble with respect to properties such as, project application domain, project size and programming languages used etc. The relationship between FLOSS projects were determined by constructing an implicit network of FLOSS projects based on the properties of shared developers. The implicit network was constructed by using social network analysis. However, our research study focuses on the relationships at the organizational level through project and developer multi-homing concept rather than the project level. The paper [35] shows us the relationships through common developers between projects. But, we will consider the relationships between two different FLOSS organizations through common projects & developers. Then, we will construct the relationships network model for FLOSS organizations by using social network analysis. In paper [35], the edge weights were calculated between the projects through an implicit network, but in our research study we won't be considering any edge (or) relationship weights.

The study by Gregory Madey, Vincent Freeh and Renee Tynan [36] shows us the FLOSS development at the community level. This study investigates developer and project evolution over time. It also discovers that project size and developer index i.e. the number of developers have power-law distributions/relationships within the community. In this study, a social network model of FLOSS community was modeled by using social network theory. In contrast to this study, our research study focuses on the relationships at the organizational level through multi-homing concept rather than the project level. Then, we will construct the relationships network model for FLOSS organizations by using social network analysis.

3. Methodology

This study was conducted by using Theoretical Saturation Grounded Theory approach which is a form of a qualitative data collection and data analysis methodology. According to [37], Theoretical saturation is associated with theoretical sampling for grounded theory. A grounded theory is a scientific research approach used by the researchers for the collection and analysis of qualitative data. The main purpose of choosing this research approach is to develop a theory (or) a model through a continuous comparative analysis of qualitative data collected by theoretical sampling process.This flexible research approach is required to collect huge volume of data because, data collection will be done simultaneously along with the data analysis process.A theory (or) a model can be formulated from the collected data. This research approach is also used to assess any sort of patterns (or) variations out of an investigated research area. The selection of cases during this research process will most likely produce the most relevant data that will evaluate emerging theories. However, each new case might offer a slightly different outcome. The researcher will be having a continued sampling of data and he/she will analyze the data until no new data emerges. The end point of theoretical saturation indicates that, the approach has reached a point where no new data were identified and it shows the researcher that the enough data were collected for data analysis purposes.

Grounded theory can be explained with an example. For an instance, if there are sample case 1, 2, 3 and 4. From sample case 1 and 3, we might get same pattern of data 'x' and from sample 2 we might get different data 'y'. And, from sample 4 we might not get any kind of data. So, our sampling cases can provide us data with same patterns ('x') and also variations ('y').

Some of the advantages of using this approach are: It encourages creativity, it has potential to conceptualize, it provides systematic approach to data analysis and it provides data depth and richness. Some of the disadvantages are: It is an exhaustive approach, it has potential for methodological mistake, developing hypothesis without reviewing the literature and limited generalizability [38].

This methodology was mainly chosen for this research study due to the nature of the research objectives and the data sources available. This methodology section will also describe all the data source and the techniques used to perform the data processing, as well as the data analysis used to answer all our research questions that are under investigation.The following subsection describes all these information in detailed manner.

3.1 Data Source

This research study was conducted by using the data collected from the following data sources:

1) The Open Hub data repository (http://www.openhub.net/) formerly known as Ohloh is used as a primary data source because, it holds key information about different FLOSS organization's business sectors, FLOSS organization's development focus, organization's sustainability factors, organization's licensing policy, organization's membership type and organization's structure. All these information are very essential in order to build a taxonomy that could define a FLOSS organization. This data repository also holds other key information such as FLOSS organizations, FLOSS projects and committers list etc. which are essential to determine the relationships among FLOSS organizations within the FLOSS community.

2) FLOSS organization's website is used as a another data source because, it holds key information about organizations support and services, organizations incubation process, project governance within the organization/foundation, project maintenance within the foundation, organizations project development practices, organizations IP management practices, contributors license agreement policies, organizations hosting services etc. All these information are essential in order to identify some of the key roles a FLOSS organization could have in FLOSS projects.

In addition to above two data sources, Open Hub can also be accessed using their API keys which is well documented at this following link: (https://github.com/blackducksw/ohloh_api). To access Open Hub data through API keys, you need to be an Open Hub member and one needs to request for an API key [39].

3.2 Data Collection

To answer all our research questions, we have collected relevant data about different FLOSS organizations attributes, organization's roles in FLOSS projects, FLOSS organization's portfolio projects and organizations outside projects. We have collected all these data using Open Hub data repository and FLOSS organization's website as our data sources. We have also downloaded API data related to FLOSS organizations and their projects from Open Hub repository to identify the relationship a FLOSS organization & their portfolio projects could have with an another FLOSS organization & their portfolio projects. To answer all our research goals, using Open Hub repository data source, we have collected data from all FLOSS organizations that host at least one project within their foundation.

To answer our R1 goal, we used TSGT approach to collect the following data through Open Hub API data, Open Hub repository and FLOSS organization's website. The following FLOSS organization attributes collected were:

Organization Business Type: This attribute presents information about FLOSS organizations that belongs to different business sectors such as Profit, Non-Profit, Education and Government.

Organization Development Focus: This attribute pertain to information regarding FLOSS organizations development focus on different kinds of software, service and science related projects.

Organization Licensing Policy: This attribute presents information about FLOSS organizations that deals with Free Software License Projects only (or) with both Free Software License Projects and Commercial Software License Projects.

Organization Sustainability Factors: This attribute holds information addressing different kinds of sustainability factors such as donors/revenue generators and partners (collaborators) who will have a significant impact on the evolution of a FLOSS organization.

Organization Structure: This attribute highlights information about FLOSS organization's governance structure. A FLOSS organization is primarily governed by two different groups of people namely, 1) Board of Directors (BOD) and 2) Advisory Board (AB).

Organization Membership: This attribute highlights information about different membership types within the organization such as No Membership, Free Membership and Paid Membership.

To answer our R2 goal, we used the same TSGT approach. Our study collected the following data from Open Hub repository and different FLOSS organization's website. The following data on the different roles a FLOSS organization could have in FLOSS projects were collected as follows:

Organization Support and Services: This role describes about the various support and services provided by the organization to its foundation projects.

Organization Incubation Process: This role describes about the project creation and project membership through the organization's incubation process.

Project Governance: This role pertains to the project governance activities within the foundation.

Project Maintenance: This role emphasizes the maintenance and control of the projects within the foundation.

Organization Project Development: This role focuses on the ongoing project development practices/activities within the foundation.

Organization Intellectual Property (IP) Management: This role comprises the Intellectual Property Management Practices within the foundation.

Organization's Project Acceptance Policy: This role clarifies the project acceptance processes within the foundation.

Organization Hosting Services for Projects: This role elaborates on the various hosting services provided for the projects within the foundation.

To answer our R3 goal, our study collected all essential data from Open Hub data repository by using API keys and via API calls. The Open Hub organization's API data is in XML format as shown in Figure 8. To conduct this study, the following relevant data has been collected by using TSGT approach: Organization Name, Organization Portfolio Projects, Outside/ Individual Projects. The definition for each entities according to the Open Hub API information are listed below [40].

FLOSS Organization: A FLOSS organization is an entity which contains a collection of FLOSS projects and accounts.

FLOSS Organization Portfolio Projects: A Portfolio projects are the ones which belong to a specific organization.
Note: According to this definition, a portfolio project can be claimed by only one specific FLOSS organization.

Outside Projects: Every outside project are not claimed by any specific Open Hub organizations. But, they are contributed by affiliated committers who belong to an Open Hub organization. These outside projects might be the portfolio projects of other organization (or) an individual project from an external company. From an organization perspective, all other organization portfolio projects are treated as outside projects.

Individual Projects: Individual projects are not claimed by any Open Hub organizations and these projects might be a collaborative projects between / among FLOSS organizations and external companies.

FLOSS Organization Affiliated Committers: A FLOSS organization affiliated committers are the people who belong to a specific organization and they contribute commits to organizations portfolio projects.

Outside Committers: Outside committers do not belong to any specific organization but, they contribute commits to organizations portfolio projects.

3.3 Data Processing:

We used Java program to parse the API data from the XML data format to normal text and then stored it into a database which is shown (Refer Figure 7 and 8 under appendix). To answer our R3 goal, The following information has been collected from Open Hub data repository which is relevant to answer our R3 goal.

Organization Information: Organization ID, Organization Name, Organization Home Page Link.

Project Information: Project ID, Project Name, Project Home Page Link.

Organization Portfolio Project Information: Portfolio Project ID and its Organization ID.

Organization Outside Project Information: Outside Project ID and Organization ID.

3.4 Data Analysis:

By using TSGT approach, we were able to built our information until we reached a saturation point where no new findings were obtained from the collected data.

We have set a criteria to analyze our sampling cases (i.e. data) that we collected from 88 FLOSS organizations (Refer Table 3 under Appendix for the collected data) to answer our R1 goal. Our criteria for R1 data analysis is that, if we go through 20 sampling cases without no new data/findings, then it is our saturation point.

The below following set of cases (Refer Table 3 under appendix for cases) will explain our data analysis process to answer our R1 goal. These cases will demonstrate the different kinds of qualitative data that we obtained during theoretical sampling process**.** We were able to identify similar data and as well some variations in data while comparing these cases.

Case 1: ASF is a non profit organization that is primarily sustained by donors such as volunteer and corporates. ASF is governed by the board of directors, they mostly deal with software related projects, they only hosts free software license projects and they hold free membership policy.

Case 2: Wikimedia Foundation is also a non-profit organization that is sustained by both donors and partners unlike ASF that is sustained only by donors. Wikimedia is governed by

the advisory board instead of board of directors. Wikimedia hosts only free software license projects like ASF but, they have no membership policy unlike ASF.

So by comparing Case 1 and Case 2, we can notice that, both cases have similar data in the form of organization business type and has slight variations in data in the form of governance structure, sustainability factors and membership policy attributes.

Case 7: Twitter is a profit organization that focuses its development primarily on service related projects.

Case 8: Los Alamos National Lab is a Government organization that focuses its development primarily on science related projects.

So by comparing Case 7 and Case 8, we can notice that, both cases have different data in the form of organization business type and organization development focus attributes.

Case 12: Openlab Technologies generates revenue by selling their products and solutions to sustain their foundation.

Case 22: BBOSP generates revenue by selling their services to sustain their foundation.

So by comparing Case 12 and Case 22, we can notice that, both cases have different data in the form of organization sustainability factor attribute.

Case 40: LRDE is a education organization that is primarily sustained by the student fee.

Case 55: We have noticed that, Agiliq foundation projects have no declared licenses.

So, between case 40 and case 55, LRDE organization provided us with a unique and new business type such as education foundation and Agiliq organization showed us that, none of his foundation projects have declared licenses.

According to our initially set criteria, between Case 56 to Case 75, we did not find any new emerging data and decided to end our theoretical sampling process in order reach the saturation point.

To answer our R2 goal, we used the same TSGT approach to built our information. We used the same criteria that we used to obtain results for R1. We collected data from 88 FLOSS organizations (Refer Table 1 for the collected data) to answer our R2 goal. The set criteria to analyze R2 data is , if we go through 20 sampling cases without no new findings, then it is our saturation point.

The following set of cases will explain our data analysis process to answer our R2 goal.

Case 1: ASF provides various support and services to their foundation projects. New projects can be created only when they go through Incubation process. Incubation process are mainly used within ASF. ASF is one of the few organization that assigns a single PMC to govern its foundation projects. Only within ASF, all FLOSS projects information are maintained either by PMC (or) individually by projects itself.

Case 2: Within wikimedia foundation, we have identified that, the developer cannot entirely create a new project by going through the incubation process. They can only start a new language version of an existing project by going through the incubation process.

By comparing case 1 and case 2, we have identified that, the purpose of incubation process used within ASF and wikimedia foundation are different in nature.

Case 3: We obtained a unique value when we identified that, there is only one FLOSS organization called KDE Community that does not have any hierarchical structure within the foundation.

Case 7: We identified that, twitter requires the developers from corporates to accept and submit a contributors license agreement (CLA) so that their contributions will be protected by twitter.

Case 13: 52 NIFGOSS can host open source projects managed by third parties. However, it does not protect the contributions made by the third party developers since the contributions are not covered by CLA.

By comparing case 7 and 13, we have identified that, CLA does protect the contributions made within every organization.

Case 25: We identified that, Genivi Alliance provides hosting services to its foundation projects.

Case 38: We identified that, MirOS project can be created/started by everybody who has the necessary skills.

Case 50: Tryton foundation projects are divided into sub projects. We identified that, each sub projects are also assigned to a project leader.

According to our initially set criteria, case 51 to 70 did not provide us with any new emerging data and thus, we decided to end our theoretical sampling process in order to reach the saturation point.

To answer our R3 goal, we started off by exploring the Open Hub data repository to identify, whether is there any relationships among different FLOSS organizations through project multihoming and developer multihoming concept. We searched each and every FLOSS organization and project API data manually that has been collected within the database. Our aim is to find out, whether is there any project from a FLOSS organization with single and unique Project ID has association/connection with one (or) more FLOSS organizations with unique Organization IDs.

Based on our findings, we will construct a social network among FLOSS organizations. A social network is referred to as an social structure between organizations, where a set of organizations are connected by a set of social relationships. By using social network analysis, we have analyzed the relationships and have done relationship mapping among FLOSS organizations [2]. In order to represent the relationships network among FLOSS organizations, we have used both the social network models such as graph representation and adjacency matrix representation [2]. These social network models are described in detail under Result analysis section.

After we derived the relationship network among FLOSS organizations, by using TSGT approach, we will go through each and every case (i.e. the relationship between two different FLOSS organizations presented within the network). Then we will identify the different key reasons behind those relationships and we have done this by going through the FLOSS organizations websites and checked , how those two organizations have a relationship. For an example: ASF, Wikimedia and Twitter are shown within the network as, they have relationships with each other. At first, we considered the relationship between Apache and Wikimedia. Next, we considered the relationship between Apache and Twitter. And finally, we considered the relationship between Twitter and Wikimedia. We will consider all the relationships in the network and we will find out the reasons behind them. While considering a relationship between two different FLOSS organizations, simultaneously we will go through their websites to find out, what are the key reasons behind those relationships and how those key reasons are contributing to these relationships. If 15 sequential relationships does not provide us with any new emerging data, then it is our saturation point.

4. Result Analysis

In this section, the data analysis findings discussed in the previous section are presented with the goal to answer our research objectives mentioned in the chapter 1 above.

4.1.1 RQ1: What defines a FLOSS organization?

To answer this research goal, we have explored some of the FLOSS organizations using Open Hub data repository. According to our set criteria, we were able to determine some of the key attributes and values that could define a FLOSS organization.

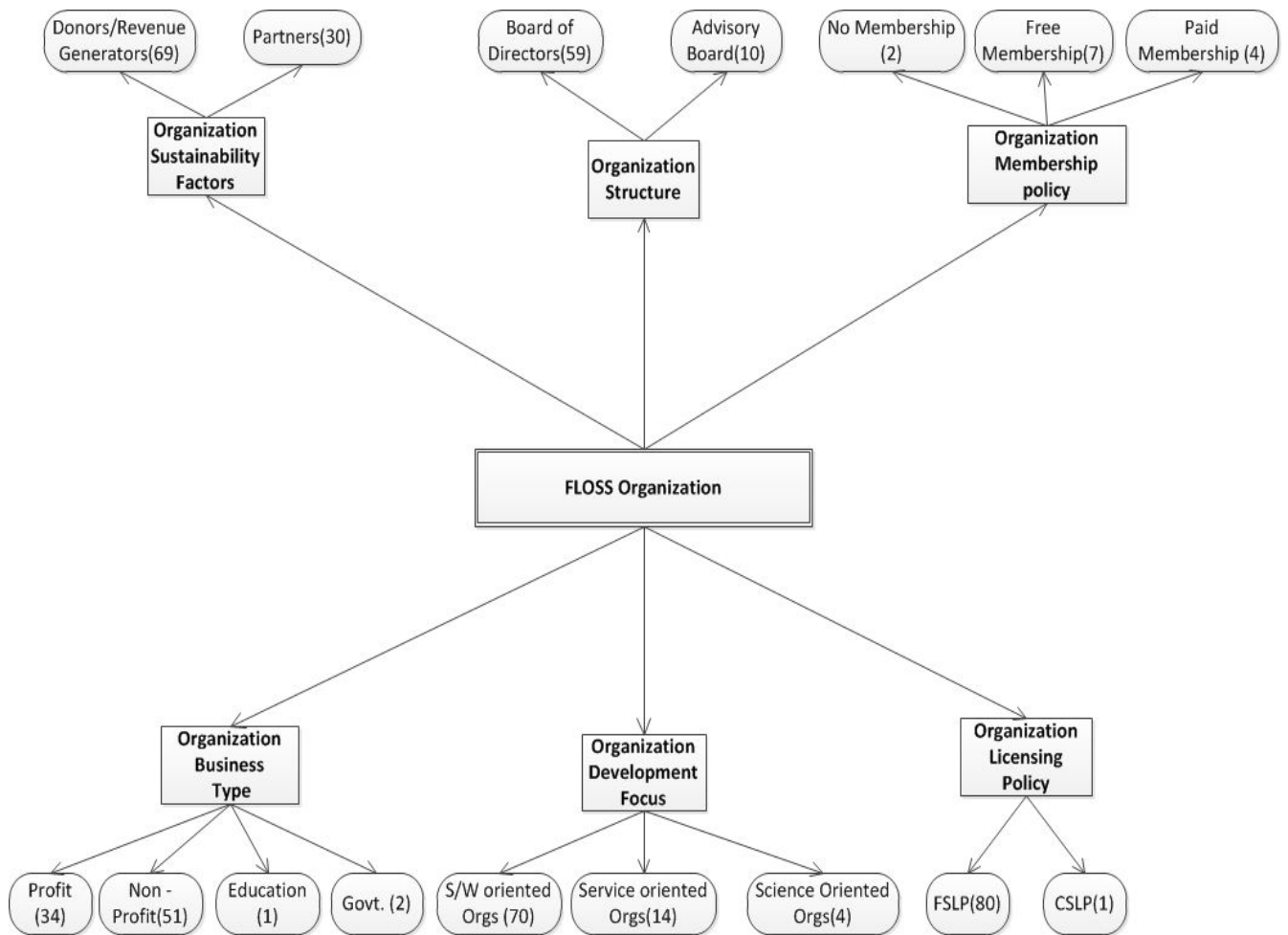Figure 1: A Taxonomy defining a FLOSS organization

We defined a FLOSS organization by developing a taxonomy (Refer Figure 1 above for taxonomy diagram) that demonstrates some of the key attributes and values of a FLOSS organization. Through our developed taxonomy, we were able to demonstrate all the key attributes that holds different set of values. For an example, Organization's business type

attribute holds four different set of values such as Profit, Non-Profit, Government and Education.

A Profit (or) Commercial FLOSS organizations mostly deals with software related projects. These organizations usually generates revenue by selling their own products, services and solutions. These organizations primarily collaborates with different corporates and technical partners worldwide. These organizations are primarily governed by the BOD who are responsible to govern both the foundation and its projects.

Non-Profit organization's mostly deals with the software related projects. These organizations are primarily sustained through volunteers who contribute code as part of their donations. They primarily collaborates with external companies,educational institutions, volunteers and industries worldwide to get funds for the ongoing project development within their foundation. Most of these organizations are also primarily governed by the BOD whose responsibilities are to govern both the foundation and its projects.

A Government FLOSS organizations mostly deals with the science related projects.The government distributes the public money (i.e. taxes) to support the growth of the government FLOSS organizations. These organizations are primarily governed by the BOD who are responsible for the management of the entire foundation's activities.

An Education FLOSS organizations also mostly deals with the science related projects. These organizations mainly focus on the scientific and academic research, while collaborating and providing education to the general public. These organizations receive donations and funds mainly through the government and student fees

FLOSS organizations deals with both Free Software License projects and Commercial Software License projects. A Free Software License allows the user of a piece of software the extensive rights to modify and redistribute that software. The copyright holder (i.e the author of the software) can remove the copyright law restrictions by associating the software with a free software license that allows the user these rights. BSD and MIT Licenses are considered as the standard Free Software Licenses. A Commercial or Proprietary Software License is produced for sale or to serve commercial purposes. GNU GPL License is considered as the standard Commercial Software License.

FLOSS organizations evolve through different kinds of donors/revenue generators and partners such as volunteers, corporates, open source organizations, software products, government agencies, educational Institutes and Investors. These donors and partners are some of the key sustainability factors that influences the development of a FLOSS organization.

FLOSS organizations are governed by two different groups of people, 1) Board of Directors (BOD) and 2) Advisory Board (AB). The Board of Directors have the decision making authority and they are responsible for governing the organization/foundation. The BOD committee can be formed by a group of people such as Founders, Investors, Directors etc. An Advisory Board does not have the decision making authority and they are only responsible for assisting or giving advice within the organization. The AB committee can be formed by a group of people such as Senior Management, Executives, Volunteers etc.

FLOSS organizations have different types of Membership. No Membership (NM) type does not have any members within the foundation. Free Membership (FM) type allows any members to join the foundation without any membership fee. Paid Membership (PM) type allows only the paid members to be part of the foundation.

We have shown the overall numerical data of different values that falls under each attribute. For an example, our taxonomy shows that, the value Profit (34) under organization business type indicates that, there are 34 FLOSS organization's that belong to profit business sectors. The value service oriented orgs (14) under organization development focus attribute indicates that, 14 FLOSS organizations from various business sectors deals with primarily with service related projects and thus they are considered as a service oriented organizations.

The Tables (Refer 4 to 9 under appendix) shows us the numerical data of different FLOSS organizations that holds information about their key attributes and values. These statistical table data's are described below:

Table 4 shows the total number of FLOSS organizations that belongs to different business sectors. Table 5 shows that most non profit organizations deals with software related projects. It also shows that, most profit organizations deals with service related projects. Some FLOSS organizations deals with both software and service related projects. There are different kinds of software and service related projects. For an example, a software project can be a multimedia software, utility software (or) a database software project. A service project can be a internet service (or) financial service project.

Table 6 indicates that, only non profit organizations deals with both free software license Projects and commercial software license projects. From Table 4, we identified that FLOSS organizations such as VideoLAN deals with both Free Software License and Commercial Software License projects. Within Open Hub repository, we found out that the project x264 hosted under VideoLAN foundation has both Free Software and Commercial Software Licenses. We also found from Open Hub repository that, every OpenStack and Arquillian Universe foundation projects uses Apache license. Every Grid Protection Alliance (GPA) foundation projects uses Eclipse Public license. Furthermore, we found that, organizations such as Kendra Initiative, Agiliq and The Internet Engineering Task Force have no declared licenses for their foundation portfolio projects.

Table 7 indicates that most Nonprofit organizations are primarily sustained through different kinds of donors. On the other hand, most profit organizations generate revenue by selling their own products, services and solutions in order to sustain themselves. Furthermore, it shows that, only few FLOSS organizations sustain through collaboration with different kinds of partners worldwide.

Table 8 shows that more non-profit organizations are governed by the Board of Directors. However, it reveals that FLOSS organizations such as HomeBrew, Ignite Realtime, Swathanthra Malayalam Computing, The MirOS Project, Grid Protection Alliance (GPA), Institut de Génomique, OpenXC Research Platform, LEAP Encryption Access Project, Savoir-faire Linux and Evil-Co are not governed by either the board of directors nor by the advisory board. It also shows Education and Government organizations are governed only by the board of directors.

Table 9 shows that, only few non-profit organizations hold all three different membership types. None of the government (or) education organizations provided us with membership type information. We also found out that, some organizations such as OWASP and OpenMRS did not provide us with membership type information during our data collection process.

Furthermore, findings from (Refer Table 3) shows us that, FLOSS organizations such as, The Internet Engineering Task Force and The Mifos Initiative deals only with service related projects and thus these organizations are considered as service oriented organizations. Organizations such as VideoLAN and Homebrew deals only with software projects and they are considered as software oriented organizations. Organizations such as Los Alamos National Lab and Argonne National Laboratory deals only with science related projects and they are considered as science oriented organizations. There are few other organizations such as Black Duck Software and OpenStack that deals with both software and service related projects and these organizations are considered as Multi-Purpose oriented organizations.

In addition to this, Table 3 under appendix shows us that most FLOSS organizations deals with Free Software License projects. Most non-profit FLOSS organizations sustain through different kinds of donors and partners in order to evolve in the FLOSS community. Most profit, nonprofit and government FLOSS organizations are primarily governed by the board of directors.

5.1.2 RQ2: What role do FLOSS organizations have in FLOSS Projects?

To answer this research goal, we explored some of the FLOSS organizations using different FLOSS organization's website and according to our set criteria, we were able to identify some of the key role a FLOSS organization could have in FLOSS projects. The table 1 below demonstrates some of the key roles.

S.No	Orgs role in FLOSS projs	Description of the roles
1)	Organization Support and Services	● Organizations can limit the contributor's legal exposure, while they work on Foundation projects. Example: ASF and Gentoo ● They can provide organizational, legal, financial & consulting services, tools and fund raising advices to its projects.
2)	Organization Incubation Process	● Any new project that wants to become a member (or) join in a foundation (or) any new project to be created under a foundation must strictly go through the organization incubation process. ● Incubation process is only used to create the new versions of an existing project and they are not used for creating entirely a new project. Example: Wikimedia foundation ● Individuals are responsible for the creation of projects. However, under Eclipse foundation, a project can be started/created with some pre-existing code. ● A project can be started/created by anyone with necessary skills.
3)	Project Governance	● Organizations assigns a single project management committee (PMC) consisting of people to govern/manage every projects and subprojects. Example: ASF and Tryton
4)	Project Maintenance	● All projects information are maintained either by project management committee (PMC) or individually by projects itself. Example: ASF
5)	Organization Project Development	● Some organization has no hierarchical structure which gives the contributors the sufficient freedom to express their creativity and contributions to make every project development successful. Example: KDE

6)	Organization Intellectual Property(IP) Management	- Organizations owns IP management rights to protect its foundation projects while restricting their contributors. Example: OuterCurve foundation, Eclipse and Gentoo. - A project at any level within a foundation might receive organization IP clearance for contributions and third party libraries. - IP management rights enables and encourages the participation of organization software developers to develop software collaboratively in FLOSS community for swift results. - The foundation software development and project management practices exists in order to support good software IP Management practices and to foster a growing community. - They can protect IP and financial contributions while limiting the contributor's legal exposure. - When a CLA is signed by the developers, foundations protects the developers contributions on its portfolio projects. Example: Twitter and 52 NIFGOSS. - However, third parties managing the hosted projects within a foundation are not protected by the CLA.
7)	Project Acceptance Process	Projects are accepted by the sponsor (i.e. if the sponsor is the foundation board) through voting. Example: OuterCurve foundation.
8)	Organization Hosting Services for Projects	- Organizations provide various project hosting services and tools to promote the FLOSS development. Example: OSGeo and Genivi Alliance. - They hosts non generic projects and a wide variety of other mailing lists for projects,committees and special interest groups.

Table 1: FLOSS organizations role in FLOSS projects

FLOSS organization can provide the legal, financial and consulting services etc; to its foundation projects. They can provide tools and also offer advice to its projects on how to raise funds. They can provide essential support to protect the intellectual property (IP) and financial contributions and it can limit the contributors legal exposure, while they work on its foundation projects.

A FLOSS project can be created within the foundation either by an individual (or) by anyone with necessary skills. In order to create a new FLOSS project within an organization (or) to join as a new project within an organization, the project must go through the organizations incubation process. Under some FLOSS organizations, incubation processes are used to create new versions of an existing project and are not for creating entirely a new project. Some FLOSS projects should start with some pre-existing code before they go through the incubation process. These incubation processes are useful for new projects to learn the community-defined open source processes. New projects while going through the incubation process will be monitored by the foundation mentors. These mentors will be released from their duty once the project advances to the mature phase.

FLOSS organizations usually assigns a single Project Management Committee (PMC) consisting of project leaders to govern every project and sub-project. PMC welcomes new contributors (i.e volunteers) to contribute on their foundation projects. Foundation mentors usually work with PMC to help in the evolution of the Project Community. All FLOSS projects within a foundation are maintained either by PMC or individually by projects itself. Organization that lacks a proper hierarchical structure can give the contributors the sufficient freedom to express their creativity and contributions to make every project development successful within a foundation.

FLOSS organizations IP Management practices enables and encourages the participation of software developers from different organizations to develop software collaboratively in FLOSS community for swift results. A FLOSS project at any level might receive IP clearance for contributions and external party libraries. The foundation software development and project management practices exists in order to support good software IP Management and to foster a growing community. Some foundation are responsible for managing the IP management rights in order to protect its portfolio projects and to restrict contributors. FLOSS organizations usually protects the developer's contribution to its portfolio projects when the developer signs the Contributors License Agreement (CLA). The CLA is specially designed to protect the developer's contribution. However, CLA does not change the ownership of developers contribution. Organizations usually do not protect the hosted projects that are managed by the third parties in a foundation with its Contributors License Agreement.

New FLOSS projects are accepted in a foundation only after the project information is distributed to the sponsor (i.e. if the sponsor is the foundation board) that will accept the project through a voting process. A FLOSS organization can hosts a wide variety of services for its foundation projects. It hosts mailing lists for projects, committees and special interest groups in order for good communication within the foundation. The foundation provides hosting services for both generic and non-generic projects. Organizations also provide tools to promote FLOSS development.

The overall summary of results from Table 1 shows us that, FLOSS organizations such as ASF, Gentoo and SpringSource provide various support and services to their foundation projects. Organization incubation process are mainly used within ASF, Wikimedia Foundation, Eclipse Foundation and MirOS project. Foundations such as ASF and Tryton assigns a single Project Management Committee to govern their projects. Only within ASF, all FLOSS projects information are maintained either by PMC or individually by projects itself. Only organization such as KDE does not have any hierarchical structure. This lack of hierarchical structure gives the contributors enough freedom to express their creativity and contributions to make every project development successful. Some organizations such as Outercurve Foundation, Eclipse and Gentoo owns IP management rights to protect their

foundation projects while restricting their contributors. A project at any level within a foundation might receive organization IP clearance for contributions and third party libraries. IP Management rights within a foundation enables and encourages the participation of organization software developers to develop software collaboratively in FLOSS community for swift results. The organization software development and project management practices exists in order to support a good software IP Management practices and to foster a growing community. Organizations such as Twitter and 52 NIFGOSS protects the developers contributions on its portfolio projects,when a CLA is signed by the developers. However, a CLA does not protect the hosted projects managed by the third parties within a foundation. All projects under Outercurve Foundation are accepted by a sponsor (i.e. If a sponsor is the foundation board) through a voting process. Organizations such as OSGeo - The Open Source Geospatial Foundation and GENIVI Alliance provides various project hosting services and tools to promote the FLOSS development. These organizations also hosts non generic projects and a wide variety of other mailing lists for projects,committees and special interest groups.

5.1.3 RQ3: What is the extent of Multi-homing in FLOSS Organizations?

According to the Open Hub API definition, a single portfolio project is claimed (or) hosted only under one specific FLOSS organization [26]. From the collected API data, manually we explored to identify the relationship between two FLOSS organizations through project multihoming, whether is there any overlapping projects between two FLOSS organizations i.e. any project with same project ID hosted under (or) claimed by more than one organizations as a portfolio project. Every FLOSS organization and FLOSS project are specified with unique ID numbers in database. Some of the projects are listed as portfolio projects of FLOSS organizations, we have checked these portfolio projects with unique project ID have connection with multiple FLOSS organizations. But, we found that project with unique project ID has connection with only one FLOSS organization as a portfolio project, we couldn't find any project hosted under or claimed by multiple organizations as a portfolio project. Therefore, based on project multi-homing concept, we concluded that, there are no overlapping portfolio project between two different FLOSS organizations.

Through the developer multi-homing concept, we identified that, two different organizations can have a relationship, whereby the affiliated committers from one FLOSS organization contributes to the other organizations portfolio projects. The Figure 2 below explains the relationships between different FLOSS organizations through the developer multi-homing concept.

Through the developer multihoming concept, the affiliated committers from different FLOSS organizations can also contribute to individual FLOSS projects. But since this study mainly focuses on the organizations, we did not consider the individual projects information that could have relationships with organizations through their committers.
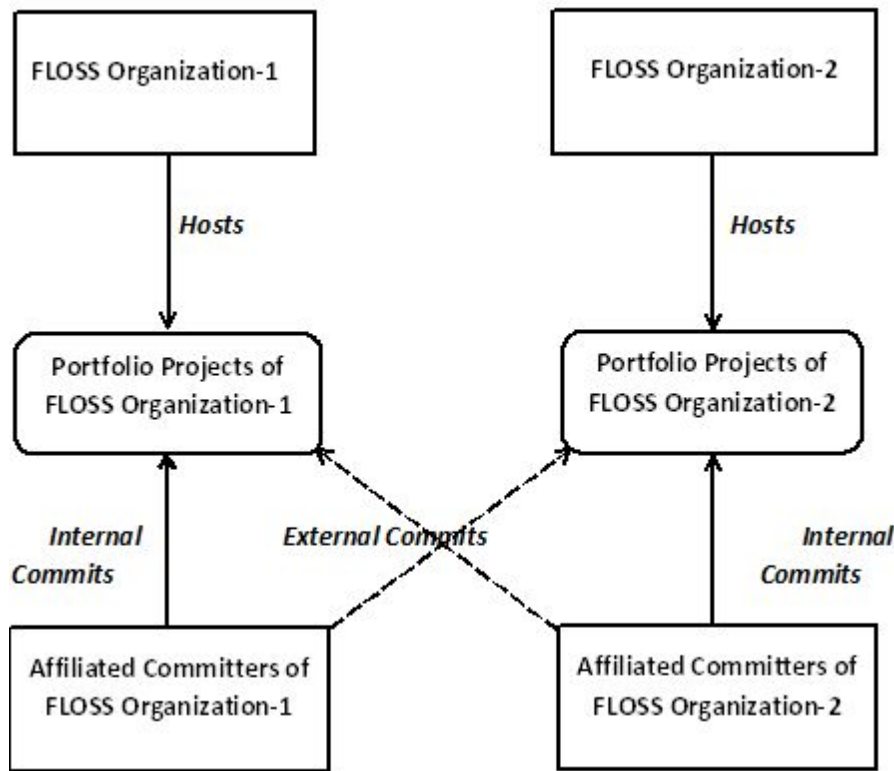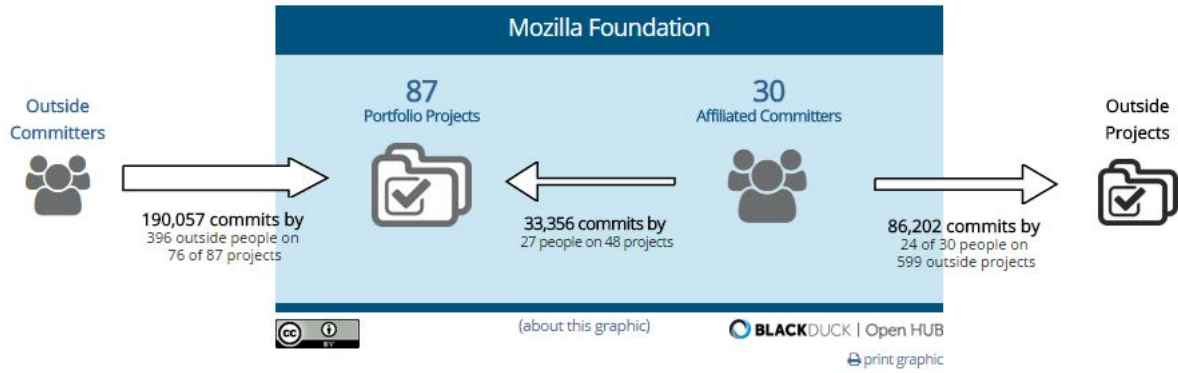
Figure 2: The relationships between different FLOSS organizations through developer multi-homing.

In the database (Refer Figure 9), we identified that multiple FLOSS organizations with unique organization ID have connections with their outside projects through the developer multi-homing, where those organization's affiliated developers are contributing their commits to the outside projects (i.e other organization's affiliated projects or individual projects).

Simultaneously, we also went through each and every FLOSS organization's page on Open Hub repository to find out their outside projects which are contributed through their affiliated committers. For this study, we have considered the outside projects, only if they are claimed by an organization.

For an example, in the below Figure 3, we can see that Mozilla foundation has some outside projects to which, Mozilla's affiliated developers are contributing their commits. There are some projects which are not claimed by any organization and these projects are considered as individual projects. We also found out that, only one project is claimed by the organization 'homebrew' and 3 affiliated committers contribute to that single project.

Figure 3: Screenshot of Mozilla foundation's outside projects on the Open Hub repository.

Here, either two different organizations receive commits for their projects from both sides i.e. two different organization's committers contribute to each other organization's projects (or) only one organization's developer contributes/commits to other organization's projects.

Next, we have considered all the connections/relationships among different organizations and the following screenshot below (Figure 4) shows the adjacent matrix table of relationships. In the following screenshot below, '0' indicates 'NO' relationship, '1' indicates there is a relationship.

S.NO.		1	2	3	4	5	
		Apache	wikimedia	KDE	Mozilla	Twitter	Tarent S
1	Apache	0	0	0	1	1	
2	Wikimedia	0	0	0	0	0	
3	KDE	0	1	0	0	0	
4	Mozilla	1	0	0	0	0	
5	Twitter	1	0	0	0	0	
6	Tarent Solutions Gmbh	0	0	0	0	0	
7	Los Alomos	0	0	0	0	0	
8	XCFE Desktop	0	0	0	0	0	

Figure 4: Screenshot of adjacent matrix table representation of relationships

The above screenshot (Figure 4) is the adjacent matrix table representation of the relationships among FLOSS organizations. The figure above demonstrates us that, Apache has a relationship with both Mozilla and Twitter Foundations. Likewise, Mozilla and Twitter also has a relationship with Apache. These relationships have been indicated with value '1'. The Wikimedia and Apache has 'NO' relationship and they have been indicated with value '0'. With this same approach, we have identified the relationships among all other organizations. The below network graph (Figure 5) shows us the partial snapshot of the relationship network among different FLOSS organizations. The nodes present in the network graph represent FLOSS organizations and the links between nodes represent the relationships among FLOSS organizations [65].
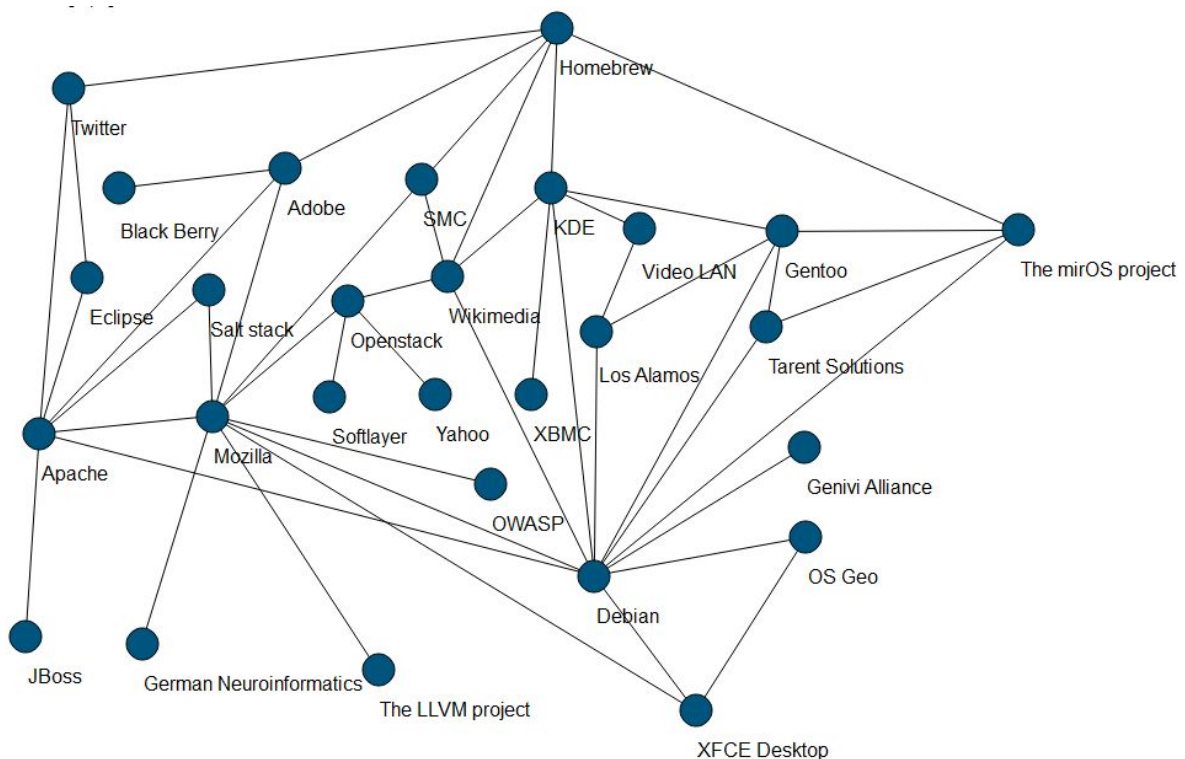

Figure 5: The partial snapshot of relationship network among FLOSS organizations

In order for us to identify the similarity factors (or) key reasons behind these relationships, by using TSGT approach, we have considered each and every relationship as a sampling case. We used manual approach to search for the appropriate information through various online sources such as organization's websites, forums etc. We have identified the relationships among different FLOSS organizations and some of the key reasons that influenced these relationships by using TSGT approach. These key reasons describes, how the relationships are formed between two different FLOSS organizations. The list of possible key reasons for the relationships among FLOSS organizations are shown in Table 10 under Appendix. We have gone through 56 relationships/cases in total to find out the key reasons. Some of the

reasons are same, some are completely different and some are similar but with slight variations. Table 10 shows us that, last 15 relationships (from relationship serial number 42 to 56) did not provide us with any new emerging reasons (or) data and henceforth, we have reached our saturation point. Then we came up with some of the unique key reasons that influenced the relationships among different FLOSS organizations. The following Table 2 below shows some of the unique key reasons to describe how one FLOSS organization is having relationships with the other FLOSS organization.

S.No	Unique Key Reasons for the Relationships among FLOSS Organizations.
1	A FLOSS organization might provide the add-ons/plug-ins to another FLOSS organization's products. Example: Eclipse - Apache, Xfce desktop - Mozilla
2	A FLOSS organization might provide financial funding(or)sponsor contributors to a another FLOSS organization's projects. Example: Twitter - Apache
3	A FLOSS organization products might have tie-up/collaborate with other FLOSS organizations products. Example: JBoss - Apache, KDE-Debian
4	A FLOSS organization might provide/produce packages for other FLOSS organization's products. Example: Gentoo - KDE, Home brew - KDE
5	A FLOSS organization might use another FLOSS organization's infrastructure, softwares/tools/products and services for their own business operations and services. Example: Yahoo - Openstack
6	A FLOSS organization's key person such as the founder, lead developer/maintainer and manager might be employed by other FLOSS organization. Example: Debian - Tarent solutions
7	Two different FLOSS organizations may have a single person as manager for their foundation projects. Example: The MirOS project - Tarent solutions
8	A FLOSS organization might host or distribute other FLOSS organization's products and services. Example: Adobe - Blackberry
9	A FLOSS organization might provide generic modules and functions to work with other FLOSS organizations software implementations. Example: Saltstack - ASF

Table 2: Unique key reasons for relationships among FLOSS organizations

5. Discussion

The primary goal of this research study was to explore different FLOSS organizations, FLOSS organization's roles in FLOSS projects and to identify the relationships among FLOSS organizations within the FLOSS field.

The results from Figure 1 shows us the taxonomical structure that highlights some of the key attributes and values of a FLOSS organization. Based on the available definition from the literature [30], we found that, a FLOSS organization can also be termed as an foundation. We have identified that, a FLOSS organization/foundation might belong to one of the following business sectors: Profit, Non Profit, Government (or) Education. These different business sectors serve different purposes to help both the organization and its foundation projects evolve within the FLOSS field. A FLOSS organization focuses on its development by mainly dealing with one of the software (or) service (or) science related projects. Projects hosted under an organization deals with only Free Software License (or) both Free Software and Commercial Software Licenses. A FLOSS organization evolves with the support of different donors and partners who influences the evolution of these organizations. FLOSS organizations are usually governed by either of two different groups of people such as the Board of Directors (or) the Advisory Board. The board of directors and the advisory board are responsible to manage, control and maintain the governance of the organization and its projects within the FLOSS Community. FLOSS organizations have different types of membership policy such as No membership, Free membership and Paid membership within the FLOSS community. A FLOSS organization regardless of its business sector will choose one of the membership policy to sustain its growth in the FLOSS community.

Next, the results from Table 1 shows us the different roles a FLOSS organization could have in FLOSS projects. We have noticed that, FLOSS projects hosted only under ASF and Gentoo foundations are provided with different organization support and services such as, limiting the contributor's legal exposure while working on the foundation projects and protecting the intellectual property & financial contributions. Any new FLOSS project to be created (or) wants to become a member (or) join in a foundation must strictly go through the organization incubation process. But, incubation process under organization like wikimedia foundation are only used to create new versions of an existing project and not used for creating entirely a new project. A project hosted under any FLOSS organization can be created by anyone with necessary skills. But, under organization like Eclipse Foundation, a project can be started/created with some pre-existing code. Some organization like ASF and Tryton assigns a single project management committee, who are responsible to govern, manage and control all of its foundation projects and subprojects. We have noticed that, only within ASF, all projects information are maintained either by project management committee (PMC) or individually by projects itself. Only organization such as KDE community does not provide a hierarchical structure. This lack of hierarchical structure gives the contributors the sufficient freedom to express their creativity and contributions to make every project

development successful within the KDE community. Organizations such as OuterCurve Foundation, Eclipse and Gentoo owns IP management rights to protect their foundation projects while restricting their contributors. A project at any level within a foundation might receive organization IP clearance for contributions and third party libraries. Organization IP management rights enables and encourages the participation of organization software developers to develop the software collaboratively in a FLOSS community for swift results. In order to support a good software IP Management practices and to foster a growing community, there exists an organization software development and project management practices. Organizations such as Twitter and 52 North Initiative for Geospatial Open Source Software protects the developers contributions on its portfolio projects, when a CLA is signed by the contributors. However, a CLA does not protect the hosted projects managed by the third parties within a foundation. Organization such as OuterCurve Foundation has a sponsor who is part of the foundation board. This sponsor is responsible for accepting all projects within a foundation through a voting process. Organizations such as OSGeo and GENIVI Alliance provides various project hosting services and tools to promote FLOSS development. These organizations also hosts non generic projects and a wide variety of other mailing lists for projects, committees and special interest groups.

Furthermore, we have explored to identify whether is there any relationships among different FLOSS organizations through project (or) developer multi-homing concept. In order to identify these relationships, we have collected relevant data by using Open Hub repository as our main data source. Based on the collected data evidence, we have identified that there exists no relationships through project multi-homing, since a single FLOSS project is not shared, hosted (or) claimed by two (or) more FLOSS organizations. But we found out that, different FLOSS organizations have relationships through developer multi-homing, since an affiliated developer from one FLOSS organization contributes to other FLOSS organizations portfolio projects. We have considered the information about the number of FLOSS organization's outside projects and the number of affiliated developers that are contributing on these outside projects. Then, we have built a relationship network to show the relationships among those FLOSS organizations. According to TSGT approach, we have considered each and every relationship between two different FLOSS organization as our sampling case, and then we have identified the key reasons behind those relationships by going through the specific organization's websites and available online resources. According to the obtained results, we have identified that, two FLOSS organizations can have relationships because of the following key reasons: A FLOSS organization may provide or produce plug-ins/add-ons to other FLOSS organizations products. For an example, the Xfce desktop provides add-on to Mozilla's Thunderbird application. A FLOSS organization may provide funding (or) sponsor their contributors to other FLOSS organization and its projects. For an example, Twitter provides financial funding as well as contributors to the Apache software foundation.Yahoo also provide financial funding to OpenStack foundation. A FLOSS organization's products might have a tie-up with other FLOSS organization's products. The Xfce and KDE desktops have tie-up with Debian operating system. A FLOSS

organization may provide packages for other FLOSS organization's products and services. For an example, HomeBrew is providing the packages for the KDE desktop applications to install on OS X. Homebrew also provides packages to Mozilla's add-ons on OS X. A FLOSS organization might be using other FLOSS organization's softwares, services, infrastructure, tools or products for its own business operations and services. For an example, Sony Mobile and Yahoo are using the OpenStack platform infrastructure for their business purposes. A key person such as the founder, lead developer, maintainer or manager from one FLOSS organization might be employed by other FLOSS organization. Both FLOSS organization's might have a single person as common manager to manage their FLOSS projects i.e. a single person acts as a manager for both organization's projects. For an example, both Tarent solutions Gmbh and the MirOS project have a single person as their manager to manage their projects and as well as, the same person is the founder of the MirOS project who is employed by Tarent Solutions Gmbh. A FLOSS organization might host and distribute other FLOSS organizations products and services. For an example, Blackberry hosts and distributes Adobe apps on Blackberry world to Blackberry mobiles. A FLOSS organization may provide generic modules and functions to work with other FLOSS organization's software implementations. For an example, SaltStack is providing generic modules and functions to work with apache software foundation's implementations.

We used TSGT approach during our data collection and data analysis phase in order to obtain results for all our research questions. We have set criteria to collect and analyze our data. During our data collection phase, we have only collected data from FLOSS organizations that hosted at least one portfolio projects. The reason behind this criteria is due to the time constraints and also we believed that, only organizations with hosted projects will provide significant data to obtain results for all our research questions. According to our R2 goal, we need to identify the FLOSS organization's role in it's portfolio projects. So, if we consider a FLOSS organization that has no portfolio projects, then it will be impossible to obtain the key results. In our R3 goal, we need to identify the relationships among the FLOSS organizations through project and developer multihoming i.e. any single project is hosted (or) claimed by multiple FLOSS organizations (or) a developer from a FLOSS organization is contributing to another FLOSS organization's portfolio projects. So, it is very clear that, project information is very significant and without projects information, it will be difficult to derive the relationships between FLOSS organizations.

During our data analysis phase, we have also set criteria to reach our saturation point. Our criteria is that, if we go through 20 continuous sampling cases for R1 and R2, and 15 continuous sampling cases for R3 where no new data emerges, then that is our saturation point. The reason behind setting this criteria is to save our time and to avoid coming across repeated data from different organizations for a longer period of time. Setting this criteria to obtain the saturation point is significant because of the huge volume of data we need to handle during our exploratory study. Also, the primary reason behind choosing this TSGT flexible approach is due to the nature of our research study, which is an exploratory study and

also due to the data sources available. Using this approach, we have gone through each and every organization's web page and Open Hub repository to identify some of the key attributes and values of a FLOSS organization and the different roles a FLOSS organization could have in FLOSS projects. Then, we have identified the relationships between two different FLOSS organizations and summarized some of the unique key reasons (Refer Table 2) that influenced the relationships among those FLOSS organizations.

Implications for research community:

This research findings would provide all the future researchers with an understanding of FLOSS organizations and its various types which exists within the FLOSS arena. Our findings will demonstrate some of the key attributes and values of different FLOSS organizations in a taxonomical structure. Our study will also demonstrate some of the roles a FLOSS organization could have in FLOSS projects. Since, there is a lack of research on the FLOSS organizations and the relationships among FLOSS organizations, our study will be one of the efforts amongst few researches done on FLOSS organizations and the relationships among FLOSS organizations through multi-homing concept. Since there are numerous number of FLOSS organizations within the FLOSS platform, our research study will be significant to guide the future researchers to learn and understand about different FLOSS organizations and their key attributes. Our findings would also be useful for the research community to identify and build the relationships among FLOSS organizations and FLOSS projects. The key reasons behind the relationships also show that how FLOSS organizations are collaborated with each other and evolve.

Implications for Industry:

The future novice adopters such as firms, organizations and developers who wish to adopt (or) join an FLOSS components (or) create their own FLOSS components will learn about different FLOSS organizations. Our findings will guide them to understand about the different types of FLOSS organizations that exists in FLOSS arena, their key attributes such as organizational structure, sustainability factors, membership policies, licensing policies and their development focus. They will get all these information in a well structured and categorized taxonomical structure. In addition to this, they can also learn about, how FLOSS organization hosts (or) manages its FLOSS projects, the IP management policies on projects, the new project creation in the open source platform etc. Through the relationships among FLOSS organizations and the key reasons behind those relationships, the novice adopters can learn, how two different FLOSS organizations form a relationship and how they collaborate and evolve within the FLOSS arena. All these vital information will be useful for the future novice adopters before they create (or) join in a FLOSS components.

5.1 Threats to Validity

This section identifies some of the threats that may affect the validity of this research study.

5.1.1 Construct Validity

Construct validity threat is the degree to which a studied operations reflects what the researcher intended to study according to research goals [41]. In this research study, a construct validity can be an assumptions made while conducting this study. We were not able to define project multi-homing due to lack of literature evidence. To mitigate this threat, through the developer multi-homing definition, we made an assumption to define project multi-homing concept. By using multi-homing concept, we discovered that, our initial assumptions of two different organizations having relationship through an overlapping project is not true. Thus, to minimize this validity threat, our study used developer multi-homing as an alternative approach to identify the relationships among FLOSS organizations.

5.1.2 Internal Validity

Internal validity threat is the prospect where external factors may affect the study results. The researcher might be aware of these factors but, others might not be aware of them [41]. We found out that, increasing growth of new organizations and projects within the Open Hub repository may also affect our study results. To mitigate this threat, our study will consider only FLOSS organizations that host at least one portfolio project. In addition to this, our study will be based on a specific period of time because the data collected during this particular period of time will be considered for validation process. During our data collection process, some of the FLOSS organizations and individual projects within the Open Hub repository did not provide us with a relevant data that is essential to conduct this study. It is not feasible for us to enquire about the missing information through Open Hub data repository. However, in order to minimize these validity threats, we used FLOSS organizations websites as our data source in order to find essential information.

5.1.3 External Validity

External validity threats reflects to what degree the results of this study can be generalizable [41]. Generalizability is one of the validity threats of this study because, this study has used Open Hub data repository as the main source for collecting data. To minimize this validity threat, We have considered FLOSS organization's website data and other external web links to improve our study results. Some of the FLOSS organization's (such as OpenMRS, Open Labs technologies, Thousand parsec etc) affiliated developers are not contributing to other FLOSS organizations projects and they don't get commits from other FLOSS organization's

affiliated developers. To minimize this validity threat, relationship among some of the FLOSS organizations were not taken into account to build a relationships network.

5.1.4 Reliability

Reliability is the prospect that is concerned with, how the study data and data analysis are dependent to the researcher. This means, how the results would be if the same study will be conducted by other researcher? [41]. Since our study deals with huge volume of qualitative data, obtaining a saturation point within limited amount of time available could affect our study results. In order to mitigate this threat, we have set criteria to analyze our data and to obtain the saturation point.

6. Conclusion and Future Work

This research study investigated about different FLOSS organizations, FLOSS organization's roles in FLOSS projects and the relationships among FLOSS organizations within the FLOSS ecosystem. Based on our findings, we claim that our proposed methodology could identify the key attributes and values of a FLOSS organizations through a developed taxonomy and the FLOSS organizations key roles in FLOSS projects. Our findings also identified the relationships among FLOSS organizations through developer multi-homing. Based on the derived relationships among FLOSS organizations, we have modeled a relationships network among FLOSS organizations. Then, we found out some of the key reasons that could influence the relationships among FLOSS organizations. However, our findings showed that, two different FLOSS organizations do not have an relationship through project multi-homing.

Next, our study results could open new gates for future researchers to explore questions like what are the relationships between individual projects and FLOSS organizations, what factors are influencing the relationships between individual projects and FLOSS organizations, why the affiliated developers from one FLOSS organization are contributing to other FLOSS organization's projects & individual projects and what is the motivation behind their contribution, how FLOSS organizations can attract and engage external companies in order to sustain its foundation projects.

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Appendix:

Org Business Type	Org Name	Org Sustainability Factors	Org Structure	Org Development Focus	Org Licensing Policy	Org Member ship
Non Profit	ASF	Donors:Volunteers and Corporates	Governed by BOD	Software Projects	FSLP	FM
Non Profit	Wikimedia Foundation	Donors:Volunteers. Partners: NIH	Governed by AB	Software Projects	FSLP	NM
Non Profit	KDE Community	Donors: Corporates	Governed by AB	Software Projects	FSLP	FM
Non Profit	Eclipse Foundation	Donors:Corporates, Partners: OSADL.	Governed by BOD	Software Projects	FSLP	FM
Non Profit	OWASP	Donors:Corporates.	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Mozilla foundation	Donors and Partners: Google.	Governed by BOD	Service Projects	FSLP	NM
Profit	Twitter	Donors: Corporates.	Governed by BOD	Service Projects	FSLP	N/A
Government	Los Alamos National Lab	Donors:Government, Partners: Industries	Governed by BOD	Science Projects	FSLP	N/A
Non Profit	OpenMRS	Donors: http://openmrs.org/about/support/	Governed by AB	Service Projects	FSLP	N/A
Profit	tarent solutions GmbH	Partners:Corporates.	Governed by AB	Software Projects	FSLP	N/A
Profit	jBOSS	Donors:Corporates.	Governed by BOD	Software Projects	FSLP	N/A
Profit	Openlabs Technologies	Revenue by selling their products and solutions.	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	52 NIFGOSS	Partners: Corporates	Governed by AB	Software Projects	FSLP	N/A
Non Profit	Thousand Parsec	N/A	N/A	N/A	N/A	N/A

Non Profit	oVirt	Donors: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	OuterCurve Foundation	Donors: Corporates	Governed by BOD	Software Projects	FSLP	PM
Non Profit	Xfce Desktop Environment	Donors: https://www.bountysource.com/teams/xfce	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Debian	Donors, Partners: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Profit	AllWorldIT	Partners: https://helpdesk.iitsp.com/allworldit/	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	OSGeo	Donors: Volunteers	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	VideoLAN	Donors, Partners: Individuals and Corporates	Governed by BOD	Software Projects	FSLP and CSLP	N/A
Profit	BBOSP	Revenue by selling their services.	Governed by BOD	Service Projects	FSLP	N/A
Profit	Yahoo! Inc	Revenue by selling their services	Governed by BOD	S/W & Service Projects	FSLP	N/A
Non Profit	GNN	Donors: Educational Institutes	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	GENIVI Alliance	Donors: http://genivi.org/genivi-members	Governed by BOD	Software Projects	FSLP	N/A
Profit	SaltStack	Revenue by selling their products.	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	CrossWire Bible Society	Donors:Volunteers Partners: Bible societies.	Governed by BOD	Software Projects	FSLP	N/A
Profit	ASI	Partners: Mozilla Foundation.	Governed by BOD	Software Projects	FSLP	N/A

Non Profit	XBMC Foundation	Donors: http://kodi.tv/xbmc-sponsor-page/	Governed by BOD	Software Projects	FSLP	FM
Non Profit	SMC	Donors:Volunteers Partners: Govt and Industries.	N/A	Software Projects	FSLP	N/A
Profit	MongoDB	Partners: https://www.mongodb.com/partners/list	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Gentoo Foundation	Donors: Corporates/firms and Organizations.	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	GPA	Donors:Volunteers.	N/A	N/A	FSLP	N/A
Profit	SoftLayer, an IBM Company	Revenue by selling their services	Governed by AB	Software Projects	FSLP	N/A
Non Profit	OpenStack	Donors: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Homebrew	Donors: Volunteers	N/A	Software Projects	FSLP	N/A
Non Profit	The LLVM Project	N/A	N/A	Software Projects	FSLP	N/A
Non Profit	The MirOS Project	Donors:Individuals and Corporates.	N/A	Software Projects	FSLP	N/A
Non Profit	TVLES	Donors:Volunteers.	Governed by BOD	Software Projects	FSLP	N/A
Education	LRDE	Donors:Student Fee.	Governed by BOD	Science Projects	FSLP	N/A
Non Profit	ON. Lab	Donors: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Asciidoctor	Donors: Volunteers.	Governed by BOD	Software Projects	FSLP	N/A
Profit	Crate.IO	Donors: https://crate.io/about/	Governed by BOD	Software Projects	FSLP	N/A
Profit	plaimi	N/A	Governed by BOD	Software Projects	FSLP	N/A

Profit	Sony Mobile	Revenue by selling their services.	Governed by BOD	S/W and Service Projects	FSLP	N/A
Government	Argonne National Laboratory	Donors:Government.	Governed by BOD	Science Projects	FSLP	N/A
Profit	TheGrid	Donors: Investors	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Ignite Realtime	Donors: Corporates, Partners	N/A	Software Projects	FSLP	N/A
Profit	OpenXC Research Platform	Donors:Volunteers.	N/A	Software Projects	FSLP	N/A
Non Profit	Tryton Foundation	Donors: Individuals and Corporates	Governed by BOD	Software Projects	FSLP	N/A
Profit	PayPal	Partners: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	gPodder	Donors: Volunteers	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	Kaltura	Donors: Volunteers, Partners	Governed by AB	Software Projects	FSLP	N/A
Profit	Wind River	Partners: Corporates	N/A	Software Projects	FSLP	PM
Profit	Agiliq	Revenue by selling their services.	Governed by BOD	S/W & Service Projects	No declared licenses	N/A
Non Profit	Translate	Donors: Corporates	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	the OpenAustralia Foundation	Donors & Partners: Volunteers	Governed by BOD	Software Projects	FSLP	FM
Profit	Yellowen Inc	Revenue by selling their	Governed by BOD	Software Projects	FSLP	N/A

		softwares, Partners:Corporates.				
Profit	LEAP	Revenue by selling their software, Partners: https://leap.se/en/about-us/partners	N/A	Software Projects	FSLP	N/A
Non Profit	Whiley	Donors:Volunteers.	Governed by BOD	N/A	FSLP	N/A
Profit	Remedy IT	Partners: Corporates	N/A	Software Projects	FSLP	N/A
Profit	Surevine	Revenue by selling their services, Partners: https://www.surevine.com/eco-system/	Governed by BOD	Service Projects	FSLP	N/A
Profit	Async Open Source	N/A	N/A	N/A	N/A	N/A
Non Profit	The TYPO3 Project	Donors: Technology supporters	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	FlightGear	N/A	N/A	Software Projects	FSLP	N/A
Non Profit	Haiku, Inc	Donors: Volunteers	Governed by BOD	Software Projects	FSLP	FM
Non Profit	Kendra Initiative	Donors: Volunteers.	Governed by BOD	Software Projects	No declared licenses	N/A
Profit	dasz.at OG	N/A	N/A	N/A	N/A	N/A
Non Profit	DuraSpace	Donors:Grant Institutions, Members,Corporates.	Governed by BOD	Service Projects	FSLP	PM
Non Profit	The MetaBrainz Foundation	Donors: Corporates	Governed by BOD	Software Projects	FSLP	PM
Non Profit	Candango Open Source Group	N/A	N/A	N/A	N/A	N/A

Profit	Savoir-faire Linux	Revenue by selling their products, Partners: https://www.savoirfairelinux.com/en/partenaires	N/A	Software Projects	FSLP	N/A
Non Profit	MPIFPR	Donors:Volunteers.	Governed by AB	Science Projects	FSLP	N/A
Profit	TeleStax	Revenue by selling their software, Partners: http://www.telestax.com/partners/	Governed by BOD	Software Projects	FSLP	N/A
Profit	Acsone SA/NV	Partners: https://www.acsone.eu/page/partners	Governed by BOD	Software Projects	FSLP	N/A
Profit	Evil-Co	Revenue by selling their softwares.	N/A	Software Projects	FSLP	N/A
Profit	Catalyst IT	Revenue by selling their services, Partners: http://catalyst.net.nz/about-us/partners	Governed by BOD	Service Projects	FSLP	N/A
Profit	Black Duck Software, Inc	Partners: https://www.blackducksoftware.com/partners	Governed by BOD	S/W & Service Projects	FSLP	N/A
Profit	CSC	Partners: Corporates	Governed by BOD	S/W & Service Projects	FSLP	N/A
Non Profit	TIETF	Donors:Volunteers.	Governed by BOD	Service Projects	No declared licenses	N/A
Non Profit	ownCloud	Donors:Volunteers.	Governed by BOD	Software Projects	FSLP	N/A
Non Profit	The Mifos Initiative	Donors: http://mifos.org/about	Governed by BOD	Service Projects	FSLP	N/A

		-us/supporters/, Partners: http://mifos.org/directory/				45
Non Profit	Institut de Génomique	Donors:Volunteers.	N/A	Science Projects	FSLP	N/A
Non Profit	Arquillian Universe	Donors:Volunteers.	Governed by AB	Software Projects	FSLP	N/A
Profit	SpringSource	Revenue by selling their softwares.	Governed by AB	Software Projects	FSLP	N/A
Profit	CISOfy	N/A	N/A	Software Projects	FSLP	N/A
Non Profit	The GNOME Foundation	Donors: https://www.gnome.org/foundation/	Governed by BOD	Software Projects	FSLP	FM
Non Profit	TSCA	Donors:Fundraising Team Members.	Governed by BOD	Software Projects	FSLP	N/A

Table 3: Key attributes of different FLOSS organizations

Organization Business Type Attribute	No of Organizations
Profit/Commercial	34
Non Profit	51
Government	2
Education	1

Table 4:Organization Business Type Attribute

Organization Development Focus Attribute	No.of Profit Orgs	No.of Non Profit Orgs	No.of Govt Orgs	No.of Educ Orgs
Software Oriented Projs	28	42	0	0
Service Oriented Projs	9	5	0	0
Science Oriented Projs	2	0	1	1

Table 5: Organization Development Focus Attribute

Organization Licensing Policy Attribute	No.of Profit Orgs	No.of Non Profit Orgs	No.of Govt Orgs	No.of Educ Orgs
FSLP	31	46	2	1
CSLP	0	1	0	0

Table 6: Organization Licensing Policy Attribute

Organization Sustainability Factors Attribute	Different Kinds of Donors and Partners	No of Profit Orgs	No of Non Profit Orgs	No of Govt Orgs	No of Educ Orgs
Donors/ Revenue Generators	Volunteers, Corporates, Government, Educational Institutes, Investors, Products and Services	20	46	2	1
Partners	OS Orgs,, Corporates, Govt, Volunteers and Industries	16	13	1	0

Table 7: Organization Sustainability Factors Attribute

Organization Structure Attribute	No of Profit Orgs	No of Non Profit Orgs	No of Govt Orgs	No of Educ Orgs
Governed by BOD	22	34	2	1
Governed by AB	3	7	0	0

Table 8: Organization Structure Attribute

Organization Membership Attribute	No of Profit Orgs	No of Non Profit Orgs	No of Govt Orgs	No of Educ Orgs
No Membership	0	2	0	0
Free Membership	0	7	0	0
Paid Membership	1	3	0	0

Table 9: Organization Membership Attribute

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Figure 6: Open Hub Organization API data in XML data format.

Figure 7: Screenshot of the database with FLOSS organizations data

ID	ANALYSISID	AVERAGERATING	CREATEDAT	DESCRIPTION	DOWNLOADURL	HOMEPAGEURL	HTMLURL	ISMANUALLYINSERTED	MEDIUMLOGOU
0	0	0	*NULL*	*NULL*	*NULL*	*NULL*	*NULL*	1	
1	0	4.22665	2006-10-10 15:51:31	Subversion has rapidly become the version control ...	http://subversion.apache.org /packages.html	http://subversion.apache.org/	https://www.openhub.net /p/subversion	0	https://s3.amazo /cloud.ohloh.net /attachmen...
2	0	-1	2006-10-10 15:51:31	This library provides a simple way to create and i...		https://actions.dev.java.net/	https://www.openhub.net /p/actions	0	
3	0	4.55556	2006-10-10 15:51:31	Boost was begun by members of the ISO C++ Standard...	http://sourceforge.net/project /showfiles.php?group...	http://www.boost.org	https://www.openhub.net /p/boost	0	https://s3.amazo /cloud.ohloh.net /attachmen...
4	0	4.69697	2006-10-10 15:51:31	The core libraries shared by Mozilla applications.	http://free.ahrcloud.com	http://www.ahrcloud.com	https://www.openhub.net /p/mozilla	0	https://s3.amazo /cloud.ohloh.net /attachmen...
5	0	-1	2006-10-10 15:51:31	Boisjoli web-based role-playing game.		http://sourceforge.net/projects /boisjoli	https://www.openhub.net /p/boisjoli	0	

Figure 8: Screenshot of the database with FLOSS projects data

Organisation_ID	outsideProjects_ID
6	1
249	1
284	3
246	4
246	9
312	9
137	15
149	15
312	15
75	25
406	25
532	25
7	26
180	26
468	30
532	34
312	36
434	36
47	43

Figure 9: Relationships between FLOSS organizations and outside projects.

S.No	Relationship between two FLOSS Organizations	Key Reasons behind those Relationships
1.	ASF - Eclipse	● Eclipse is providing plug-ins to Apache projects. [http://www.eclipse.org/subversive/] [https://code.google.com/a/eclipselabs.org/p/eclipse-plugin-apache/]
2.	ASF- Mozilla	N/A
3.	ASF - Twitter	● Twitter is sponsoring ASF financially. [http://www.apache.org/foundation/thanks.html] ● Twitter is also contributing in ASF projects through their committers. [https://engineering.twitter.com/opensource/community]
4.	ASF - JBoss	● JBoss web server collaborated / integrated with Apache http server. [http://www.jboss.org/products/webserver/overview/]
5.	ASF - Debian	● The Debian is providing Apache's packages to install Apache software under Debian operating system. [https://wiki.debian.org/Apache]
6.	Wikimedia - Debian	● The Debian provides packages for MediaWiki [https://wiki.debian.org/MediaWiki]
7.	Wikimedia - SMC	N/A
8.	Wikimedia - Openstack	● Wikimedia is using Openstack to build test and development infrastructure. [http://readwrite.com/2011/01/03/how-the-wikimedia-foundation-i]
9.	Wikimedia - Homebrew	N/A
10.	Wikimedia - KDE	N/A
11.	KDE - Debian	● KDE desktop environment softwares are tie-up with Debian. ● There is also KDE-Debian maintenance team which focus on KDE softwares successful installation on Debian environment. It also provides KDE related packages for Debian. [https://wiki.debian.org/KDE] [http://pkg-kde.alioth.debian.org/]
12.	KDE - VideoLan	N/A

13.	KDE - XBMC	N/A
14.	KDE - Gentoo	● Gentoo is providing Packages for KDE desktop applications. [https://wiki.gentoo.org/wiki/KDE] [https://packages.gentoo.org/package/kde-base/kde-meta]
15.	Mozilla - OWASP	● Mozilla is using OWASP security tools and add-ons for its firefox browser. [https://addons.mozilla.org/En-us/firefox/collections/dennis_groves/owa/][https://blog.mozilla.org/security/2012/09/13/owasp-zap-the-firefox-of-web-security-tools/]
16.	The Xfce Desktop - Mozilla Foundation	● The Xfce desktop provides add-ons for Mozilla Thunderbird application. [https://addons.mozilla.org/en-US/thunderbird/addon/xfce-adwaita/]
17.	Mozilla - Debian	● Mozilla Debian team provides various versions of Mozilla related packages on Debian OS based systems. [http://mozilla.debian.net/]
18.	Saltstack - Mozilla	N/A
19.	Mozilla - Adobe	● Adobe provides plugins to Mozilla firefox browser [https://support.mozilla.org/en-US/kb/install-flash-plugin-view-videos-animations-games]
20.	Mozilla - Openstack	● Mozilla has experimented the Openstack cloud infrastructure and services. [https://bugzilla.mozilla.org/show_bug.cgi?id=963165]
21.	HomeBrew - Mozilla	● For installation of Mozilla add-ons on the OS X, the homebrew provides packages. [https://developer.mozilla.org/en-US/docs/Mozilla/Developer_guide/Build_Instructions/Mac_OS_X_Prerequisites]
22.	Mozilla - LLVM project	● Mozilla uses the LLVM's Clang compiler to compile the Firefox browser. [https://developer.mozilla.org/en-US/docs/Compiling_Firefox_With_Clang_On_Linux#Introduction]
23.	Twitter - Mozilla	● Twitter provides add-ons for mozilla firefox browser [https://addons.mozilla.org/En-us/firefox/addon/twitter-app/]
24.	Twitter - Homebrew	N/A

25.	Los Alamos - Debian	● The Los Alamos computers systems are pre-installed with Debian operating system. [http://laclinux.com/en/About]
26.	Los Alamos - VideoLAN	N/A
27.	Los Alamos - Gentoo	N/A
28.	Tarent Solutions - Debian	● The employee of the Tarent is a maintainer/contributor of Debian. [https://lists.debian.org/debian-ctte/2014/11/msg00167.html]
29.	Tarent Solutions - Gentoo	N/A
30.	Tarent Solutions - The Miros Project	● The founder of the Miros Project organization is Thorsten Glaser. He is also an employee at Tarent Solutions Gmbh. [https://www.mirbsd.org/wlog.htm] ● He is the lead developer and manager of the FLOSS projects at these two organizations. [https://www.openhub.net/orgs/MirOS] [https://www.openhub.net/orgs/tarent] ● Some of the commits to the Miros Project were sponsored by Tarent. [http://comments.gmane.org/gmane.os.miros.cvs/24802]
31.	The Xfce Desktop - Debian	● The Xfce is one of the desktop options in the Debian desktop. [https://wiki.debian.org/Xfce]
32.	The Xfce Desktop - OS Geo	N/A
33.	Debian - OS Geo	● Debian provides packages to OS Geo applications. [http://blends.debian.org/gis/tasks/osgeo-web-server]
34.	The Miros Project - Debian	● Both are operating systems. The Miros Project founder and manager is the maintainer at Debian project. [https://wiki.debian.org/ThorstenGlaser]
35.	Adobe - Black Berry	● Black Berry is host and distributing Adobe applications for its mobiles [https://appworld.blackberry.com/webstore/search/adobe/?lang=en&countrycode=SE]
36.	German Neuroinformatics - Mozilla	N/A

37.	Yahoo- Openstack	● Yahoo has gold membership at Openstack foundation. Yahoo provides funding to Openstack. [http://www.openstack.org/foundation/companies/] ● Yahoo is also using Openstack cloud computing platform for its operations and services. [https://www.openstack.org/summit/openstack-summit-hong-kong-2013/session-videos/presentation/yahoo-case-study]
38.	Genivi - Debian	● The founder of Debian automotive is a key person at Genivi alliance. [https://archive.fosdem.org/2013/interviews/2013-jeremiah-foster/]
39.	Saltstack - ASF	● The Saltstack provides generic modules and functions to work with all implementations of Apache. [http://docs.saltstack.com/en/latest/ref/modules/all/salt.modules.apache.html]
40.	Adobe - ASF	N/A
41.	Adobe - Homebrew	N/A
42.	Gentoo - The MirOS project	N/A
43.	Softlayer - Openstack	● Softlayer uses Openstack infrastructure for its business operations and services. [http://www.datacenterknowledge.com/archives/2014/10/31/new-ibm-openstack-cloud-services-launched-on-softlayer-infrastructure/]
46.	Home Brew - KDE	● Home Brew is a package management software that provides packages for easy installation of KDE's application on OS X. [https://github.com/haraldF/homebrew-kf5] [https://github.com/adymo/homebrew-kde]
47.	The miros project - Home Brew	N/A
48.	Plaimi - Gentoo	N/A
49.	Sony Mobile - Openstack	● The Sony Mobile uses Openstack as its back-end platform which hosts software for connecting online gamers. [http://www.networkworld.com/article/2186653/cloud-computing/sony-division-moves-some-services-from-aws-to-openstack.html]
50.	Sony Mobile - Eclipse	N/A

51.	Sony Mobile - Logilab	N/A
52.	Argonne National Labs - HomeBrew	N/A
53.	Argonne National Labs - The LLVM Project	N/A
54.	CZ.NIC - Debian	N/A
55.	CZ.NIC - Homebrew	N/A
56.	The Grid - GNOME	N/A

Table 10: Key Reasons for Relationships among different FLOSS organizations.