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Understanding the Command and Control (C2) through the Social Network Analysis: the case studies of Paris-Brussels terrorist attacks

NICOLÒ SPAGNA

Nota autore

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Abstract

The globalized and fragmented terrorism nowadays, has become multipolar and extremely dynamic especially with the advent of self-proclaimed Islamic State (ISIS). The Information Warfare is always a primary source for the information management in the hybrid warfare, thus it is essential to elaborate on the study of terrorist organizations in relation to their command and control systems. This research attempts to provide a better understanding of the command and control and the terrorist networks utilizing two case studies: Paris and Brussels terrorist attacks perpetrated by ISIS' operatives. This study applies a multi-level social network analysis (SNA) in order to analyze the functional and morphological structure of the network that allowed the perpetration of the attacks. The relational data used were managed through the open source intelligence process. By SNA, the local and global analysis reveals that the entire network behind the attacks has a pattern which tends to be structured as a hybrid organization: an ensemble of a traditional hierarchical structure and a fully-connected organization. The functional analysis reveals the existence of a strict and hierarchical decision-making system in which the command function was exercised. The command function was based on the capabilities and roles of several key players which are emerged as crucial for the network structure and for the planning of terrorist attacks.

Abstract

Il terrorismo di oggi è frammentato e globalizzato e successivamente all'avvento dell'autoproclamato Stato Islamico (ISIS) è divenuto multipolare, estremamente dinamico ed in costante cambiamento. All'interno di questo quadro bellico la cosiddetta *Information Warfare* diviene

sempre più primaria, per questo è essenziale approfondire lo studio dei network terroristici in funzione dei sistemi di comando e controllo. Questa ricerca tenta di fornire una maggiore comprensione del comando e del controllo utilizzando due casi di studio: gli attentati terroristici di Parigi e Bruxelles compiuti e rivendicati da ISIS. Questo studio con l'applicazione della *social network analysis* (SNA) analizza la struttura funzionale e morfologica della rete che ha operato per l'attuazione degli attacchi. A tale scopo, i dati relazionali utilizzati per l'analisi sono stati raccolti attraverso un processo di *open source intelligence*. Utilizzando la SNA, l'analisi locale e globale ha rivelato che la rete antistante gli attacchi presentava un pattern molto simile ad una struttura ibrida, in altre parole un mix tra una struttura gerarchica tradizionale e un'organizzazione completamente connessa. Mentre, l'analisi funzionale ha rivelato l'esistenza di un sistema decisionale rigido e gerarchico all'interno del quale veniva esercitata la funzione di comando. Tale funzione è stata esercitata attraverso diversi *key players* che sono emersi dall'analisi come cruciali per l'architettura della rete e quindi per la pianificazione degli attacchi terroristici.

Keywords

Rete terroristica, ISIS, analisi delle reti sociali, comando e controllo, C2, attacchi terroristici di Parigi e Bruxelles, terrorismo.

1. Introduction

In this research the author aims to provide a more understanding of the command and control (C2) of a jihadist network behind a terrorist attack. This paper is a part of the entire research related to the master's degree dissertation of the author, where social network analysis (SNA) was one of the methods used to investigate C2 in depth. In this way, the paper focuses on the main part of the research that includes the use of SNA with the aim of highlighting the features of a terrorist network and interpret them for understanding the operation of the C2. In this way, the command and control's concept can be defined in brief as «the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission» (U.S. Joint Chiefs of Staff 2016, 40). Thus the C2 is made up of a set of functions that «are performed through an arrangement of personnel, equipment, communications, facilities, and procedures which are employed by a commander in planning, coordinating, and controlling forces and operations in the accomplishment of the mission» (Baber, Harris, and Stanton 2012, 2). Instead, SNA is known as a method to reveal the characteristics of the actors' position in a group, the structure and the social movements within it. Indeed SNA is an analysis methodology for studying the scheme of interaction between the actors related to a specific graph (Wellman and Berkowitz 1988; Wasserman and Faust 1994; Scott 2012; Bie 2016). More specifically, several studies have used SNA in order

to study organizational structures of terrorist networks (Krebs 2002; Qin et al. 2005; Berzinji, Kaati, and Rezine 2012; Choudhary and Singh 2016; Bie 2016). In according to Ressler (2006) «terrorist organizations are well-suited to study using social network analysis [...] the social network analysis can provide important information on the unique characteristics of terrorist organizations, ranging from issues of network recruitment, network evolution, and the diffusion of radical ideas. Specifically, social network analysis can be used to understand terrorist networks [...]» (1). The SNA approach permits to analyze the presence or absence of a hierarchical structure, the nature of a decision-making system, the actors who hold the authority and the actors on which authority is exercised, to highlight empirically the characteristics of a network, making observations within C2 organization.

To better understand C2 of a jihadist network behind a terrorist attack, with attention to ISIS also called *Daesh*¹, we focused on two case studies in Europe: *Paris attacks* on 13 November 2015 and *Brussels attacks* on 22 March 2016 both claimed by ISIS' organization. To date, no research focused on the terrorist networks related to ISIS, furthermore the C2 related to the planning of a terrorist attack has remained largely understudied. Thus, this paper aims to answer the following research questions:

- What does the SNA and successive mappings of the collected relational data reveal about the organizational structure and functional characteristics of the ISIS' terrorist networks behind the terrorist attacks?
- What can be understood from the results of the SNA in relation to the study of C2 related to the case studies?

This paper has been divided in four parts. The first part presents the methodology and the data collection phase. The second analyzes the tactical network related to the Paris and Brussels attacks, while the third part analyzes the strategic network in relation to the tactical one. Final considerations on the results and the research limits are presented in the fourth part.

2. Data and methods

2.1. From data gathering to analysis

The data utilized for this research has been collected through the open source analysis. The process of gathering and elaboration data using open sources is called Open Source Intelligence (OSINT), that includes two fun-

¹ ISIS is for self-declared Islamic State of Iraq and Syria; **Daesh** is for *al-Dawla al-Islamiya fi al-Iraq wa al-Sham*, transliteration from the Arabic language: الدولة الإسلامية في العراق والشام

damentals concepts. Firstly, the concept of *intelligence* which is defined «the process of interpreting information to give it a meaning» (UNODC 2011, 9). Secondly, the concept of *open sources* which refers to the type of source that is publicly available, in other words not classified or closed sources have been utilized.

The intelligence process is based on the following steps: the *data collection* with the raw information about the ties between the different actors implicated in the Paris and Brussels terrorist attacks. In this way, the goal was the extrapolation of *relational data*, in fact in according to J. Scott (2012) «the methods appropriate for relational data are those of network analysis, in which the relations are treated as expressing the linkages that run between agents. Relational data comprise agents as cases together with the connections and affiliations that comprise their social relations» (3). Thus, the relational data concern «the contacts, ties and connections, and the group attachments and meetings that relate one agent to another [...]» (9).

Specifically, this research includes an extended concept of “*tie*”, such as meetings, telecommunication links, co-workers, family links, roommates and all information that highlight a connection between a couple of actors.

To verify the reliability of the source and the quality of the information collected were compared each other: *data evaluation*. The check has been done crossing the information from different sources, for instance, “*Le galaxie djihadiste – L’atelier du Parisien*” is a platform which permits to check the different ego-network about members implicated in the recent attacks, in the same way, it was also useful the report “*An Enduring Threat: Europe’s Islamist Terror Networks Then and Now*” (Webb and Sutton 2016).

In relation to the social network analysis, the raw information has been elaborated (*data elaboration*) to analyzed them. The *unit of analysis* of research is represented by tie, then the social network approach requires which relational data are imported within a square, symmetrical, matrix with the same number of rows and columns, also called *n-by-n* matrix ($n \times n$), where n represented the number of actors which compose the examined network.

In this work the relations (R) have been recorded as binary, considering the following criterion:

$$R_{a,b} = \begin{cases} \mathbf{1} \rightarrow & \text{if relation between } a - b \text{ exist;} \\ \mathbf{0} \rightarrow & \text{if relation between } a - b \text{ does not exist;} \end{cases}$$

At the same time, it is not considered the direction of the ties, in fact, working on an undirected network, the analysis considers the presence of a relation between two actors only.

2.2 A multi-level social network analysis

In order to analyze the Paris and Brussels network, it is fundamental considers different aspects of C2. In fact, the study of C2 of a terrorist organization should consider the so-called “Military Art” which underlines that the direction of any war, military operations, can be represented on three different, hierarchical levels of action: strategical, operational and tactical level.

These levels reflect the military management complexity. In according to M.N. Vego (2009) the strategic level can be divided into two sublevels: national-strategic and theater- strategic level. The national-strategic level (also called grand strategy) define the political and military goal that an organization want to achieve. Considering the grand strategy of the self-declared ISIS, consists in the *islamification* of the world through the actualization of jihād. In other words, the “grand” strategy is an action’s theory which needs the existence of a “grand” coordination for reaching the political-religious goals.

After the strategic level, there is an intermediate field of war knowledge situated between strategical and tactical level, namely operational art. Without delve too much into the explanation, the operational dimension refers to its integration capacity of strategic and tactical levels. In fact «only on this level can the abstract and mechanical extremes be fused into a functional formula», in other words, the «operational art translates [the political aims] into effective military operations and campaigns» (Naveh 2013, 7–8). In this way, with the operational art, strategic goals are operationalized in multiple sub-levels in relation to different operative theaters where the organization operates. Finally, the tactical level of war concerns the operations conducted in a small part of the operational theater. This level consists in the of operationalization strategy lower level, thus the translation of the operational art into field movements.

In this research, social network analysis has been divided in two study levels. The first level called *Tactical Analysis* refers to the tactical terrorist network analysis. In according to Asal et al. (2016) tactical terrorist network is a network «characterized by relationships among *individuals* who are *instrumental to a specific terrorist operation*», in other words this type of network is composed by terrorists strictly linked to the attack execution. The second level called *Strategic Analysis* refers to the analysis of the different groups – or people – connected each other with functions of strategic planning attack (e.g. recruitment). Networks which operate at the strategic level usually don’t move on the selected territory as a target of the attack. The following tables show utilized networks for the *tactical* and *strategic analysis*.

Table 1

<i>Level of analysis</i>	<i>Network's name</i>
Tactical analysis	Paris network; Bruxelles network;
Strategic analysis	Paris network; Bruxelles network; Verviers network; Zerkani network; Sharia4Belgium network; Resto du Tawhid network; Val de Marne network; Charlie Hebdo network; Buttes-Chaumont network; Strasburgo network; Toulouse-Artigat network.

2.3 From properties, variables and hypothesis to network metrics

In order to study C2 behind the Paris and Brussels terrorist attacks, the C2's *research concept* has been split in two main *dimensions*, the **morphological structure** and the **functional structure**. In this way, it is examined two interrelated but distinct *indicators* for both dimensions. The network's morphology consists in the overall network structure and the related ties pattern within it, in fact the morphology of a graph can be *hierarchical*, generally into an organization there are univocal relationships between the superior and the subordinate, while into a *fully connected graph* all members are connected to each other. The functional structure refers to the structure of the decision-making system that can be *centralized* or *decentralized*. A decision-making system is *centralized* if there is a specific C2 chain, with specific positions and roles, indeed the centralization refers to the existence of a command center who directly controls resources and operations throughout a unique command chain with clear lines of authority (Shapiro 2005). Decentralized decision-making system has not a clear and specific C2 chain or even with specific main actors who hold the authority, it is generally present a mutual coordination between each part of the network, then the main body of organization provides only general guidelines (Hanna 2009). Finally, it is noted that these indicators (centralized – decentralized/ hierarchical – fully connected) must be viewed as a continuum. Based on above considerations the following hypothesis was elaborated:

H1: Paris and Brussels attacks were directed by Syria through the Amn al-Kharji group as reported by different analysis (Webb and Sutton 2016; P.D.A. Speckhard and Yayla 2016; A. Speckhard and Yayla 2017; Orton

2017a). Amn al-Kharji, the ISIS' foreign intelligence service that at one time, among its different tasks, was responsible for planning and organizing terrorist attacks in the West. Thus, considering the operational context in which the attacks took place, it is hypothesized that the morphology network tends to a hierarchy organization, while the functional structure tends to a centralized decision-making system.

Finally, these indicators have been operationalized through the definition of statistics metrics. In this way, the following metrics have been applied to study both dimensions:

- Density;
- Degree centrality;
- Betweenness centrality;
- Closeness centrality.

Density measures the connectedness of a network by dividing the actual nodes of edges by the number of total possible edges. It is the most basic measure of cohesion at the network level, indeed density reflects the extent to which the nodes are connected to each other in all over the analyzed network.

In according to different studies in SNA (Borgatti, Everett, and Johnson 2013; Stollenwerk, Dörfler, and Schibberges 2016; Cunningham, Everton, and Murphy 2016) there is a diversity of measures to study the patterns and the structure of a social network. The most important used measure is *centrality*, that analyzes a node position within the context of its network. The centrality measures allow us to discover *key players* within the social network. Key players are considered the most important nodes respect other ones, in other words they tend to have the major impact on the relation pattern in the network. One of the most important centrality measures is called **degree centrality** (Freeman 1979) which counts the number of ties an actor has within the network.

The interpretation of degree centrality changes based on different networks and what connections represent. Taking in consideration a tactical terrorist network, a node with high degree centrality can be considered a representative of planning, for this reason degree centrality is a measure which generally enable analyst to identify leaders within the network. At the same time, it is important to point out that not all the nodes with high degree centrality are associated to the power's concept related to other actors. Certainly, a node with high degree centrality highlights a critical position within the network, however an interpretation is required for each case (Koschade 2006; Borgatti, Everett, and Johnson 2013).

Another important centrality measure is called **betweenness centrality** (Freeman 1979; Borgatti, Everett, and Johnson 2013). The betweenness cen-

trality of an actor is calculated as the proportion of shortest paths between pairs of other nodes within the network which pass through the initial actor. Nodes with high betweenness centrality can be considered as a broker within the network, indeed nodes need brokers for achieving other actors. In this way, nodes with high betweenness centrality control the information's flow in the net.

Finally, the last centrality measure is called **closeness centrality**, that simply measures the minimum distance of each node to the other nodes. Closeness centrality is the reciprocal of farness which for a node is the sum of the lengths of the geodesics distances to every other node. In this research, has been used the normalized closeness centrality of a node, that is the reciprocal of farness divided by the minimum possible farness expressed as a percentage. In this way, high value of closeness centrality corresponds a high node's centrality within the network. In according to Cunningham, Everton and Murphy (2016) «actors scoring highly in closeness centrality will have opportunities to access information [without intermediaries] from not only those the actors around them, but also many other actors who are considered outside of their neighborhood because, on average, they are relatively close to all other actors in the network» (149).

The degree-based measures described permit to study the **local centrality** of the network, which mean highlight the role played by individual actor within the network. In conclusion, the following research hypotheses were elaborated:

H2: In order to study the morphological and functional structure of the networks related to Paris and Brussels terrorist attacks, the analysis of local centrality permits to identify the relevant positions of the actors within the C2.

H3: In order to study the morphological structure of the networks related to Paris and Brussels terrorist attacks, the analysis of global centrality permits to identify the pattern of the network within the C2.

3. Social network analysis of Paris-Brussels terrorist group

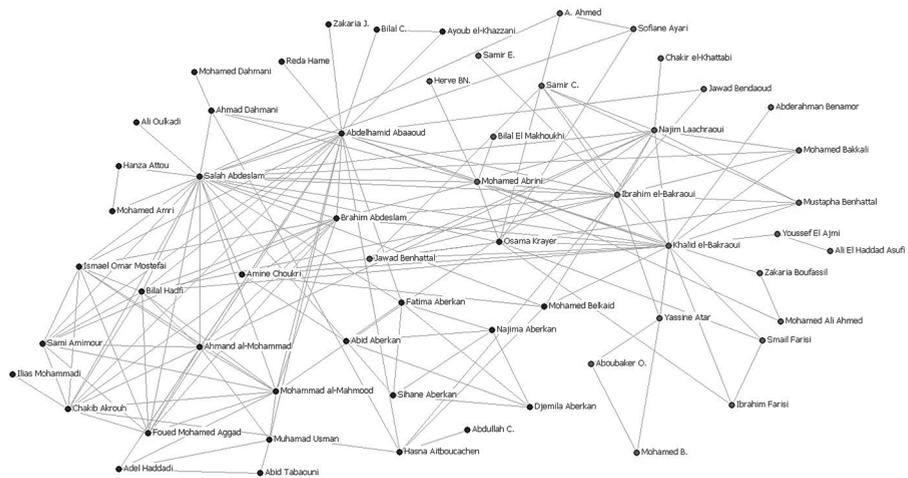
3.1 Analysis of cohesion and local centrality measures

The first analyzed network (figure 1) consists of the individuals involved in the terrorist attacks occurred on 13 November 2015 in Paris and on 22 March 2016 in Brussels. The network is made up of 58 nodes, specifically 25 belonging to the Brussels group and 33 to Paris group. The analysis of network cohesion (table 2) shows a network density of 0.097. In other words, within the network the existing connections between individuals, considering the

potential connections, are about 10%. The entire Paris-Brussels network has a low network density. In fact, network density simply describes the number of ties within the network, expressed as a proportion of the number possible (Borgatti, Everett, and Johnson 2013). Density value highlights that the Paris-Brussels group is highly centralized, because only a small number of nodes – 10% – hold most of the ties within the network.

The network’s centralization is also observable by calculating *geodesic distances*. In according to Wasserman and Faust (1994), considering the paths between a given pair of nodes within the network, these path vary in length. Therefore, a shortest path between two hypothetical nodes is referred to as a *geodesic* concept. In this way, geodesic distance is defined as a length of a geodesic between these nodes, thus the *geodesic distance* identifies the shortest length between two actors. The geodesic distance calculated within an undirected binary network is the number of links (and hence the nodes) that form the path between two nodes. In the Paris-Brussels group about 76% of the geodesic distances between nodes have 2-3 intermediaries along their respective paths.

Figure 1 - *Paris-Brussels network*



Network Parigi-Bruxelles
 Legend | Network Parigi ● | Network Bruxelles ● | Software: Ucinet/NetDraw | Source: Author's elaboration

Table 2 - *Network cohesion Paris-Brussels network*

<i>Network cohesion</i>	<i>Paris-Brussels network</i>
Nodes	58
Density	0.097
Average number of contacts for each node	5.525
Average value of geodetic distances	2.6

The analysis of the terrorist networks generally aims at identifying the key roles played by the individuals in the network. To achieve this, the study of local centrality permits to capture the relative importance of nodes in the group through different metrics. *Degree centrality* estimates how central an individual is by analyzing the number of direct relationships that he has with other individuals in the network. In fact, the idea is that a node with few edges, in relation to a node with many edges, has a low centrality (degree centrality). Considering the Paris-Brussels group, the degree centrality has been shown in table 2, where the first 11 individuals with a high value of degree centrality have been reported. Specifically, the value of *Degree* indicates the number of nodes which an individual is linked to, whereas *nDegree* refers to the normalized value of degree centrality, in other words it expresses a percentage of nodes which a specific node is in contact to.

The two most central individuals within the Paris-Brussels network are **Abdelhamid Abaaoud** connected with 40% of the nodes of the entire network ($nDegree=0.386$), and **Salah Abdeslam** connected with 43% of the nodes of the entire network ($nDegree=0.439$).

The key role of *Abdelhamid Abaaoud* and *Salah Abdeslam* is also confirmed by investigative evidence related to the terrorist attacks in Paris and Brussels. At the end of 2014 the migration crisis started in Macedonia with a subsequent escalation in the spring of 2015. In June 2015, Macedonian government initiated a legislative procedure with the aim of producing a new asylum law in accordance with the European legislative framework. But, nevertheless, on 16 June 2015, the Macedonian government, under the pressure of human rights groups, in order to mitigate the migration crisis, allowed migrants to legitimately apply for temporary asylum at the border, thus, permitting migrants to transit legally through the country for 72 hours (Šabić and Borić 2016). In June 2015, *Abdelhamid Abaaoud* exploited the Macedonian migration crisis delegating a young Algerian called *Bilal C.* to map the safe routes in the Balkans, fundamentals to allow future attackers to enter in Europe with a low risk level (Brisard and Jackson 2016). At the same time, *Abdelhamid Abaaoud* had coordinated the attack of Moroccan *Ayoub el-Khazzani* considering the information received by *Bilal C.* On 21 August 2015,

Ayoub el-Khazzani on board of Thalys train direct to Paris from Amsterdam, he tried to attack passengers with an AKM assault rifle, before he was blocked by the passengers during the terrorist operation (Le Parisien 2015b).

On the same way, *Salah Abdeslam* played a fundamental role in planning the *Paris* attacks, in fact, his support for logistics operations emerged from investigations. *Salah Abdeslam*, *Mohamed Abrini* (nDegree=0.211) and *Ahmad Dahmani* traveled together in the Netherlands for the acquisition of firearms that were used in the terrorist attacks. In addition to the acquisition of weapons, *Salah Abdeslam* carried the attackers to the different safe houses in France and Belgium. The investigations confirmed that from August and October 2015 *Salah Abdeslam* did four trips (Brisard and Jackson 2016, 6). Specifically:

- On August 30, 2015, *Salah Abdeslam* met in Kiskoros (Hungary) **Bilal Hadfi** (suicide attacker near the Stade de France) and **Chakib Akrouh** (member of commando who fired on restaurants *Le Carillon* and *Le Petit Cambodge* in *Rue Alibert* in Paris);
- On September 9, 2015, *Salah Abdeslam* likely met in Budapest **Najim Laachraoui** (nDegree=0.190) e **Mohamed Belkaid** who were present in Hungarian territory since September 3rd;
- On September 17, 2015, *Salah Abdeslam* met in Budapest **Sami Amimour**, **Ismael Omar Mostefai** and **Foued Mohammed-Aggad**, the terrorists who attacked the *Bataclan* restaurant;
- On October 2, 2015, *Salah Abdeslam* met in Ulm (Germany) **Osama Krayem**, **Sofiane Ayari** and **A. Ahmed**.

Other individuals with a high score of degree centrality within Paris-Brussels network are **Khalid el-Bakraoui** (nDegree=0.333) and the brother **Ibrahim el-Bakraoui** (nDegree=0.228). On March 22, 2016, *Ibrahim el-Bakraoui* and *Najim Laachraoui* carried out a suicide attack close to departure hall of the American and Brussels Airlines at Brussels-National Airport in Zaventem. Almost at the same time, *Khalid el-Bakraoui* carried out a suicide attack in the middle carriage of a train at *Maelbeek* metro station in the center of Bruxelles.

Another attacker, **Mohamed Abrini** (nDegree=0.211) escaped from Zaventem Airport without committing martyrdom. While he was on the run, he was nicknamed by the media as “Man in the hat”. On April 8, 2016, after two weeks the attacks in Brussels, *Mohamed Abrini* was arrested in the *Anderlecht* district (Brussels) with another facilitator of the operation called **Osama Krayem** (Boztas and Chazan 2016).

Mohamed Abrini also has a high score of degree centrality (nDegree=0.211), in fact he was present in both Paris and Brussels attacks. The day before the Paris attacks a CCTV system of a service station in *Oise* (north of Paris) filmed *Mohamed Abrini* and *Salah Abdeslam* while they were driving the car

used to carry the attackers. High scores of centralities are also associated with **Mohammad al-Mahmood** e **Ahmad al-Mohammad** (nDegree=0.211) both suicide bombers who attacked near the Stade de France on November 13, 2015. Their real identities are still unknown, Mohammad al-Mahmood was nicknamed by *Dabiq*² magazine as Ali al-Iraqi, while Ahmad al-Mohammad with the *kunya*³ of *Ukash al-Iraqi*. *Ahmad al-Mohammad is believed to have entered with Mohammad al-Mahmood as asylum seekers two months before the Paris attacks in Europe passing through Greece (on October 3, 2015), Serbia (on October 7, 2015) and Austria (on October 8, 2015) (Webb and Sutton 2016, 24). The remaining nodes with considerable scores of degree centrality refer to Paris attackers. Brahim Abdeslam (nDegree=0.211) Salah's brother who carried out a suicide attack in *Comptoir Voltaire Café*; **Chakib Akrouh** (nDegree=0.193) died with *Abdelhamid Abaaoud* and *Hasna Aitboulahcen* after detonating his explosive belt inside the safe house during the blitz of the authorities on November 18, 2015 in *Saint Denis* district (Paris). *Chakib Akrouh* has a significant degree centrality score, in fact, it is not a coincidence considering his proximity to *Abdelhamid Abaaoud* and *Abdeslam* brothers. Finally, the last terrorist called **Bilal Hadfi** (nDegree=0.193), suicide bomber, despite he presents a high score of centrality the information about him don't show any key role.*

Table 3 - Degree centrality: Paris-Brussels network

Rank	Nodes	Degree	nDegree
1	Salah Abdeslam	25	0.439
2	Abdelhamid Abaaoud	22	0.386
3	Khalid el-Bakraoui	19	0.333
4	Ibrahim el-Bakraoui	13	0.228
5	Najim Laachraoui	12	0.211
6	Mohamed Abrini	12	0.211
7	Mohammad al-Mahmood	12	0.211
8	Ahmad al-Mohammad	12	0.211
9	Brahim Abdeslam	12	0.211
10	Bilal Hadfi	11	0.193
11	Chakib Akrouh	11	0.193

² *Dabiq* is jihadist online magazine that has been spread by the self-proclaimed Islamic State until June of 2016.

³ Honorific name adopted by a fighter during the war.

With the aim of highlighting the individuals with a key role within the network, we have focused on the ability of the nodes to manage the information and resources. For this purpose, the *betweenness centrality* measure was calculated. As defined in the methodology, betweenness centrality is a measure of how often a given node within the network falls along the shortest path between two other nodes (Freeman 1979). In other words, this metric is interpreted in relation to the information and resource flow. Consequently, betweenness centrality permits to identify the *gatekeeper* positions in the net. In according to literature (Everton 2012; Berzinji, Kaati, and Rezine 2012; Borgatti, Everett, and Johnson 2013) high-betweenness nodes are in position to threaten the net and to filter information, thus generally if an individual within the network has high betweenness, many nodes need this individual to reach other nodes through efficient ways. The gatekeeper positions have power because they can decide to transmit or not a specific information – or command – to whom or when send it.

The table 4 shows the scores of betweenness centrality of the first relevant individuals of the Paris-Brussels network. *Betweenness* column refers the number of times that the node falls along the shortest path between to other individuals. While, the normalized score of *nBetweenness* column refers to the value of *Betweenness* divides by the total number of ordered pairs of nodes, then the betweenness can be interpreted as a percentage.

Table 4 - *Betweenness centrality: Paris-Brussels network*

<i>Rank</i>	<i>Nodes</i>	<i>Betweenness</i>	<i>nBetweenness</i>
1	Salah Abdeslam	498.442	31.231
2	Abdelhamid Abaaoud	491.508	30.796
3	Khalid el-Bakraoui	402.547	25.222
4	Mohamed Abrini	237.513	14.882
5	Ibrahim el-Bakraoui	167.043	10.466
6	Yassine Atar	110.000	6.892
7	Fatima Aberkan	107.298	6.723
8	Najim Laachraoui	104.589	6.553

Figure 2 - Degree centrality: Paris-Brussels network

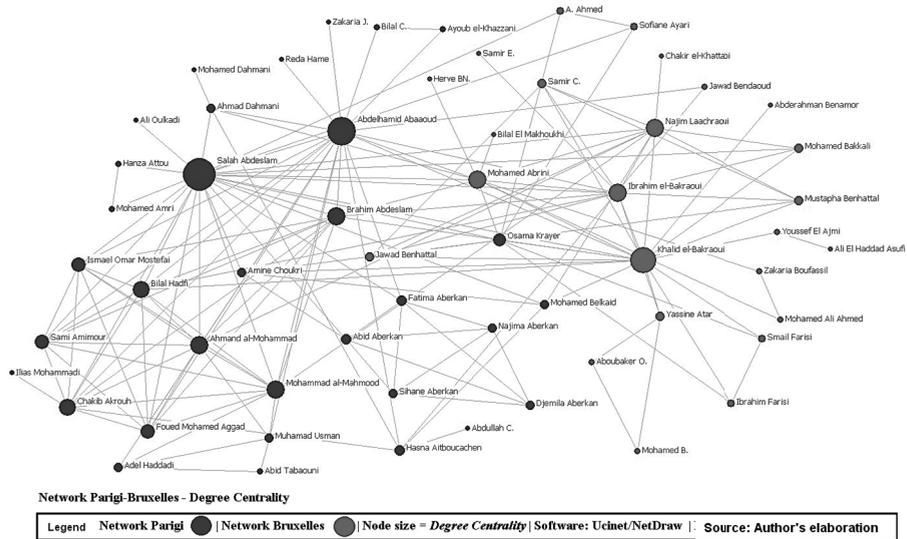
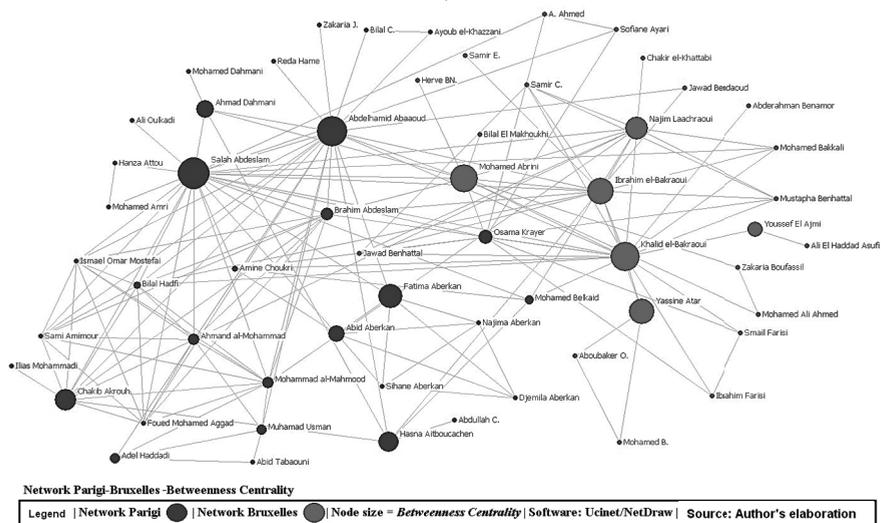


Figure 3 - Betweenness centrality: Paris-Brussels network



3.2 Analysis of the global centrality: Centralization indices

As specified before, the dimension of network centrality comprises of two different levels: **local** and **global**. If the local centrality permits to study the weight which the single node has within the network through the centrality

measures, the global centrality permits to analyze how the network is globally structured utilizing the **centralization indices**. Centralization is a property of a network as a whole, indeed it provides a metric on the extent to which an overall network has a centralized or decentralized structure. In this way, centralization and density are important complementary measures, because if density measure defines the whole level of connectedness in a network, the centralization measure defines the extent to which this connectedness is distributed around focal nodes (Abraham and Hassanien 2012; Borgatti, Everett, and Johnson 2013). As asserted by Katharina A. Zweig (2016) the concept of centralization is strictly connected to the extent of dispersion and heterogeneity of a node in a network, in other words, centralization indices refer to the extent of dispersion (inequality) in a network in comparison with a star network. In according to Gouda, Kulkarni and Elmallah (2007) «a network is called a star if the network topology consists of one center node and several peripheral nodes, and each peripheral node is connected only to the center node (by an edge)» (318).

The centralization indices are calculated in relation to the local centrality measures (*i.e.* degree, betweenness and closeness centrality), where all three centralization indices vary from zero to 1, where zero identifies a network in which all nodes are linked to all other nodes (situation that is realized with a *regular/circle network*), instead a value of 1 corresponds for all three measures to a perfect *star network*, where we have a maximum centralization structure (Wasserman and Faust 1994).

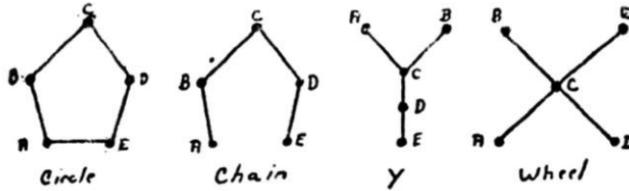
Table 5 - *Centralization indices: Paris-Brussels network*

<i>Centralization indices</i>	<i>Score</i>	<i>Percentage</i>
Degree centrality	0.3478	34.78
Betweenness centrality	0.2884	28.84
Closeness centrality	0.4326	43.26

Table 5 shows the centralization indices related to the Paris-Brussels network, and the scores show a moderate level of centralization within the network. Considering the studies of Harold J. Leavitt (1974) regarding the effects of different communication patterns on performance within groups, these represent an excellent starting point to consider the effects that different organizational structures have on the roles of actors within a network. The figure 4 shows the four distinct organizational structures defined by Harold J. Leavitt, also called **network archetypes**, based on small graph of five nodes. Leavitt (1951) also stated that if «two patterns [structure] cannot be “bent”

into the same shape without breaking a link, they are different patterns» (59), consequently he defined the *circle*, *chain*, *y* and *star* networks.

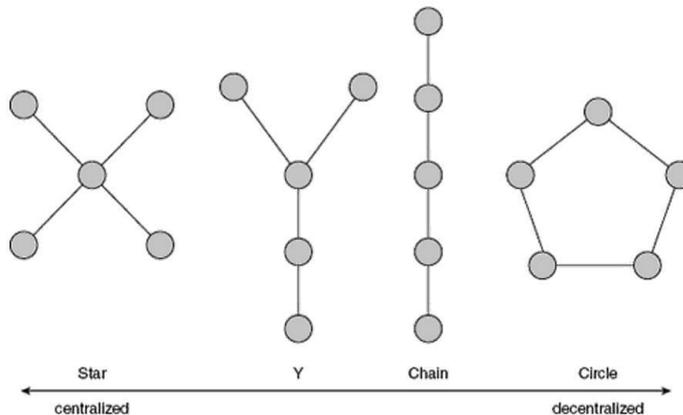
Figure 4 - *Leavitt's network archetypes* (1974, 83)



It is necessary to clarify that the four network archetypes should be considered positioned along a continuum, in fact «the circle [network], one extreme, is active, leaderless, unorganized, erratic, and yet is enjoyed by its members. The [star network], at the other extreme, is less active, has a distinct leader, is well and stably organized, is less erratic, and yet is unsatisfying to most of its members» (Jenkins et al. 2012, 33). Thus, it can be asserted that the centralization measures express the degree of disparity or variance in a network as a percentage of that of a star network of the same size. On the same way, Yang, Keller and Zheng (2016) affirm that «the greater the centralization of a network, the larger the disparity between the nodes' individual centrality measures» (61).

Considering the table 5, the centralization scores are between ~20 and ~40%, these values highlight a moderate hierarchy within the Paris-Brussels network, in conclusion there is a moderate amount of concentration in the network as whole, therefore in relation to the single actors the positional advantages are moderately distributed unequally.

Figure 5 - *Network archetypes along a continuum* (Borgatti, Everett, and Johnson 2013, 150)



3.3 Analysis of roles, fragmentation and cutpoints of the network

Analyzing Paris-Brussels group by centrality measures, the key actors in the network have been detected, indeed centrality has permitted to study the network at the node level. The centrality measures are strictly connected to the concept of power, but it must be contextualized within a planning dimension and implementation of a terrorist attack. The concept of power in this work is considered divided in three parts: *Human resources control* (i.e., the power to connect actors each other who have no direct relationships), *monitoring of intelligence* (i.e., the power to control the information's flow and to get the commands to the actors), *resource control* (i.e., the power to control the resource's flow and the logistics dimension). All these dimensions of power are interdependent. In this way, high-degree centrality nodes are highly visible in a network, therefore more vulnerable because they are at risk of detection by the authorities. In relation to the organized crime could be affirmed that the main leaders of a criminal organization tend to have high values of betweenness centrality associated with a low score of degree centrality. F. Calderoni (2014), in a research entitled "*Identifying Mafia Bosses from Meeting Attendance*", through the analysis of meeting attendance of an Italian organized crime called '*Ndrangheta*' he showed that betweenness centrality is the most significant predictor of leadership in the mafia organization. This result is significant because it has highlighted how high-betweenness actors control criminal activities more indirectly, probably with the aim of avoiding detection by the authorities. This statement in relation to the terrorist activities is not necessarily true. Although nodes with high degree centrality are more visible in a network, the nature of a terrorist activity requires that the operation's leader be in touch with most network members actively participating in the terrorist operation. It is possible to assert that in a terrorist operation – from planning to execution – there is generally a considerable shift from security to efficiency within "efficiency-security trade-off" (Morselli, Petit, and Giguère 2006), this dynamic generates a progressive deterioration of security during the overall operation. Therefore, in a terrorist operation the leader (or coordinator) as well as being actively involved in planning he has the capacity to bring information, commands, resources and individuals together (brokering role). These aspects have also been demonstrated by recent events. Taking into consideration the Barcelona attacks perpetrated on 17 August 2017, the authorities claimed the main planning director was **Abdelbaki Es Satty**, also called "The Ripoll Imam". The Imam was the planner of the entire terrorist operation and he was connected with all members of the Ripoll cell which he had also recruited and indoctrinated. Furthermore, he was also a logistics coordinator in fact he met **Ahmad Alkhald Mohamad Siham**, a known

ISIS' bomb-maker linked also with Paris attack in November 2015 (Stade de France) and Brussels in March 2016 (Zaventem), in order to receive guidelines for making the bombs. Finally, he was in contact with various exponents of other terrorist organizations, such as al-Qaida, linked to previous terrorist attacks (Reinares and Garcia-Calvo 2018).

In this perspective, considering the Paris-Brussels network, it is decided to consider those members who presents a high score of degree and betweenness centrality as key players with command power. In according to R.T. Antony (2015) «individuals at the apex of a layered hierarchical organization (president in a traditional business model) tend to have high centrality, high betweenness and moderate closeness. Because the president possesses both high centrality and high betweenness [...]» (180), for this reason «the apex of a hierarchy represents a critical network failure point»⁴. Considering the level of analysis that as specified before it is a network characterized by connections among individuals who are instrumental to a specific terrorist operation. Focusing on the tactical Paris-Brussels network the main roles have been defined and shown below:

- **Coordinator.** The actors to whom coordination of the operation is entrusted occupy a position that allows them to be in contact with the majority of the actors in the network. These possess a high level of degree centrality, and then a high capacity of social influence. It is more likely that high-degree centrality actors are more influential toward the closest individuals (Qin et al. 2005). Between coordinators and facilitators exist an informational asymmetry related to the diversity of roles with the aim of ensuring the security of the operation, reflecting a hierarchy of information (brokering role);
- **Gatekeeper.** The actors who possess a high score of betweenness centrality, but not degree centrality, are important for their ability to manage resource and information flows;
- **Leader/Supporter.** The actors who present a high score of degree centrality, but not betweenness are surely social influencers, however their role should be analyzed case by case.

For this work, it was decided to define **coordinators** those who have high levels of degree and betweenness centrality. Sociologically speaking, the leader figure refers to the ability to influence the people, however the leader does not necessarily integrate a coordinating role for the inability to handle the information (gatekeeper). In other words, the coordinator is represented by the following equation: *Coordinator = Leader + Gatekeeper*. Table 6 shows the

⁴*Ibidem*.

coordinators of Paris-Brussels group, the nodes of the network who present high scores of *nDegree* and *nBetweenness*.

Table 6 - *Nodes of the Paris-Brussels network with high scores of nDegree and nBetweenness*

<i>Nodes</i>	<i>nDegree %</i>	<i>nBetweenness %</i>
Salah Abdeslam	44	31
Abdelhamid Abaaoud	39	31
Khalid el-Bakraoui	33	25
Mohamed Abrini	21	15
Ibrahim el-Bakraoui	23	10
Najim Laachraoui	21	7

The importance of these actors in the network has also been underlined by the calculation of the **fragmentation centrality**. In according to the literature (Everton 2012; Borgatti, Everett, and Johnson 2013; Cunningham, Everton, and Murphy 2016; Zweig 2016) the fragmentation centrality is a useful topographical measure of the network, which is generally defined as the proportion of all pairs of nodes that are not tied with one other. More clearly the fragmentation centrality measures the degree to which a network is fragmented. In this way, with the aim to highlights the weight of the single nodes of the Paris-Brussels network, it has been calculated the fragmentation centrality taking in account two different scenarios: the first scenario composed by the standard Paris-Brussels network and a second scenario composed by the standard Paris- Brussels network without the actors considered coordinators as shown in table 6.

If actors considered as coordinators were eliminated from the Paris-Brussels network, what would be the weight of fragmentation?

Table 7 - *Fragmentation centrality*

	<i>Scenario 1</i>	<i>Scenario 2</i>
Fragmentation centrality	0.0000	0.686

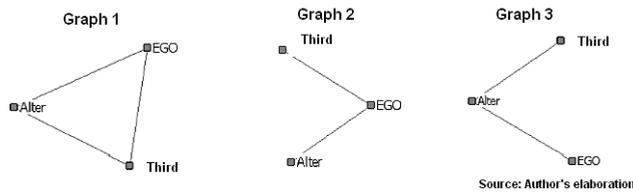
The fragmentation score for scenario 1 is tending to zero, while after the elimination of the coordinators from the network the fragmentation score is increased by almost 70%, in other words these actors have a strong weight, in fact they can easily break up the network because they assume a critical posi-

tion in the Paris-Brussels group. It is possible to identify nodes that are critical to the integrity of the network also with the **cutpoints** analysis. S.J. Strang (2014, 10) defines a cutpoint as a «single individual connecting two or more components of a network. Removing that individual should disconnect those components [...]», therefore actors whose removal disconnects the network, or a component of a network are called cutpoints or articulation points. The cutpoints analysis is a function which permits to observe the vulnerability of the system network (Council et al. 2003; Cunningham, Everton, and Murphy 2016), indeed in the Paris-Brussels network the cutpoints represent the nodes without which the implementation of the attacks would not have taken place, or it would have been more difficult. Ucinet software has been indentified 11 cutpoints. The actors defined as coordinators are reported in bold: **Abdelhamid Abaaoud**, **Salah Abdeslam**, **Mohamed Abrini**, Chakib Akrouh, **Najim Laacharaoui**, Hasna Aitboucachen, Ahmand Dahmani, Youssef El Ajmi, **Ibrahim el-Bakraoui**, **Khalid el-Bakraoui** e Yassine Atar.

3.4 Analysis of the structural holes

In order to understand the concept of structural holes defined by R. Burt (2009), it is possible to take in consideration three different types of graphs shown in figure 6 (adapted from the author from Everton 2012, 255) that consists in the triads of three individuals (a central node, *EGO*; a second node, *alter* and the *third* node) and the ties among them. The first graph presents a situation where all actors share information, trust and rules, then any social conflict between two actors can be moderated by a third person. In other words, the existence of ties between the nodes makes the concept of *group* instead of a set of *individuals*. Considering the graphs 2 and 3, the sharing of a set of social norms and trust are considerably lower than the previous graph. In the graphs 2 and 3 which are not fully connected, one of the actors (*EGO* in the graph 2 and *Alter* in the graph 3) is in strategic advantage because he is in a role of *brokering* between the other two actors. These two actors have an advantage because they can exploit the competition present among the other peripheral nodes in their favor. This strategy is called *tertius strategy*, where the *tertius gaudens* is «the third who benefits» (G. Simmel cited in Burt 2009, 30), a person who emerge successful from negotiation. In short, the absence of a tie in graph 2 (between *Alter* and the *Third*) and graph 3 (between *EGO* and the *Third*) is called **structural hole** (Nooy, Mrvar, and Batagelj 2011).

Figure 6 - Three types of graphs (triads)



On the one hand, in a network the presence of a structural hole represents «an opportunity to broker the flow of information between people, and control the projects that bring together people from opposite sides of the hole» (Zhang 2010, 18), on the other hand a fully connected graph generates a *constraint* between actors. The concept of constraint is very important, because «Burt's structural holes measure does not identify structural holes per se but rather estimates the constraint that all actors in a network face, in light of all the triads in which they are embedded» (Everton 2012, 255), for this reason a low score of constraint means more autonomy in a group, then the presence of potential roles of brokers. In relation to the analysis of structural holes (Table 8) of the coordinators (Table 6), the relative measures are explained below.

Table 8 - Structural holes measures of the coordinators reported in Table 6

Nodes	EffSize	Efficiency	Constraint	Hierarchy
Salah Abdeslam	19.320	0.773	0.131	0.030
Abdelhamid Abaaoud	16.636	0.756	0.143	0.048
Khalid el-Bakraoui	14.789	0.778	0.169	0.072
Mohamed Abrini	9	0.750	0.233	0.064
Ibrahim el-Bakraoui	8.385	0.645	0.257	0.080
Najim Laachraoui	8.167	0.681	0.268	0.077

- *EffSize*: the value of “effective size of the network” refers to the number of alters of EGO, minus the average number of ties that each alter has to other alters. The measure does not consider direct ties with EGO. From the interpretative point of view, high values of “effective size of the network” refer to a greater power of influence carried out by the focal node EGO. Finally, this measure is not standardized, it tends to a minimum value of 1, at a maximum value equivalent to the network size minus 1 (Baum and Rowley 2008; Burt 2009);
- *Efficiency*: the measure of efficiency concerns the proportion of EGO's ties to its neighborhood which are non-redundant. It is essential to define the

concept of redundancy (also called dyadic redundancy), which concerns that «ego's tie to an alter is "redundant". If A is tied to both B and C, and B is tied to C, A's tie to B is redundant, because A can influence B by way of C» (Scott and Carrington 2011). Besides, the "effect size of the network" provides guidance about the social influence and the general impact of the focal node EGO, while measure of efficiency helps us how much impact the focal node ego has on other Alters. More clearly, in relation to the achievement of the goals an individual of the network can be effective without being efficient (Hanneman and Riddle 2005). A value of 1 indicates that every tie of the network is not redundant, on the contrary a value of zero indicates a high level of redundancy, then a low efficiency of the focal node EGO. If EGO is associated with low efficiency this means that EGO could not carry out a high level of influence on the Alters because they are also within the network in a strategic position (Burt 2009);

- *Constraint*: the value of constraint identifies the level of obligation that ego has towards Alters in the network. A high score of constraint means a high level of subordination of Alters on EGO. In the same way, Hanneman and Riddle (2005, chap. 9) assert that «If ego's potential trading partners all have one another as potential trading partners, ego is highly constrained. If ego's partners do not have other alternatives in the neighborhood, they cannot constrain ego's behavior» On the contrary, low score of constraint means that EGO can carry out a high influence, then a brokerage power, on the Alters;
- *Hierarchy*: the value of hierarchy is strictly linked to the measure of constraint. Considering an EGO network, if the constraint on ego is concentrated in a single node, the hierarchy measure will tend to a higher value (tending to 1). If the total constraint is equally spread among the various Alters in the ego network, the measure of hierarchy will tend to a low value (tending to zero). In this way, hierarchy score measures the property of dependency in relation to EGO across the Alters in its neighborhood (Degegne and Forsé 1999).

In the Table 8 we can observe that the first six nodes, with a low value of *Constraint*, are the same actors (coordinators) with the highest values of *nBetweenness* and *nDegree* as reported in the Table 6. We can note **Salah Abdeslam** ($C_s=0.131^5$) and **Abdelhamid Abaaoud** ($C_s = 0.143$) have closed Constraint values tending to zero, resulting in a strong executive power and brokering role on their Alter.

⁵ C_s = abbreviation of *Constraint*

The same trend is applicable to other nodes: **Khalid el-Bakraoui** ($C_s = 0.169$); **Mohamed Abrini** ($C_s = 0.233$); **Ibrahim el-Bakraoui** ($C_s = 0.257$) and finally **Najim Laachraoui** ($C_s = 0.268$).

Another valuable measure is the *Hierarchy* – with values for all actors closed to zero – has resulted in a very important source of info: the dependency degree, known as Constraint value, referred to each Coordinator, is not concentrated in a unique Alter but is spread over the EGO's ties.

In other words, within the Paris-Brussels network, the nodes shown in Table 6, show a minimal level of subordination (as stated before: *Hierarchy* → zero). Ultimately, the tending to zero levels of *Constraint* and *Hierarchy* confirm furthermore, as the previously association of these actors with the coordination role within the network Paris-Brussels.

3.5 Final analysis of the Paris-Brussels network

Based on these consideration, it can be summarized that the Paris-Brussels network gravitates towards the following *hot nodes*:

- Abdelhamid Abaaoud;
- Salah Abdeslam;
- Khalid el-Bakraoui;
- Ibrahim el-Bakraoui;
- Mohamed Abrini;
- Najim Laachraoui.

Crossing the data emerged from the analysis of the network and descriptive information (from OSINT) linked to the actors it has been highlighted fundamental roles and key positions for a more understanding of the organizational tactical terrorist network structure analyzed.

Firstly, **Abdelhamid Abaaoud** emerges as a leading figure in this Paris-Brussels network, in relation to direct planning of attacks in Europe, and specifically in Paris. As stated by Gartenstein-Ross (2016), Abaaoud can be considered as the *tactical coordinator* of operations in Europe. Abaaoud coordinated other actors as **Sid Ahmed Ghlam** and **Ayoub el-Khazzani** to carry out other attacks and providing them operational guidance, before Paris attacks.

Abdelhamid Abaaoud has been widely supported by **Salah Abdeslam** which came a purely logistical coordination within the planning as described above. In addition to trips made by Salah Abdeslam to transport the attackers in Paris, there are other elements that show his importance within the network, reflecting the strong interconnection between the attacks in Paris and Brussels.

On 15 March 2016 authorities identified one of the first safe house of Paris-Brussels network in the municipality of *Forest* in *Rue Dries* (Belgium). During the blitz, a killed man was later identified as **Mohamed Belkaid**⁶. He was transported by **Salah Abdeslam** from Hungary to Paris on September 9, 2015. On 18 March 2016, the authorities capture **Salah Abdeslam** in *Molenbeek* district of Brussels (Belgium) along with **Soufiane Ayari**⁷. **Mohamed Belkaid** and **Soufiane Ayari** were connected to **Salah Abdeslam**, indeed, although unconfirmed, it is assumed that these three actors have supported the terrorist attacks of 22 March 2016 in Brussels (Webb and Sutton 2016).

The remaining members of Paris-Brussels network to avoid being discovered by the authorities, they decided to accelerate the planning and modify the targets. For this, on 22 March 2016 two different groups went into action: *the cell of Zaventem*, composed by **Ibrahim el-Bakraoui**, **Najim Laachraoui** and **Mohamed Abrini** – the first two you carried out a suicide bombing at the Zaventem airport – while the *cell of the Maalbeek*, who attacked the metro station, was composed by **Khalid el-Bakraoui** and **Osama Krayem**. The coordinating role of brothers **Khalid** and **Ibrahim el-Bakraoui** revealed by the social network analysis is confirmed also by different evidences.

Khalid and **Ibrahim el-Bakraoui** in addition to being involved in suicide operations, they rented the apartments used as safe houses in Paris and Brussels attacks. The brothers managed the renting the apartments⁸ used by bombers of Paris in the town of *Charleroi* (Belgium) and apartments in the towns of *Forest* and *Schaerbeek* located around the capital of Brussels. The use of these apartments as logistical bases has been confirmed by the investigative sources. In fact, the fingerprints of **Abdelhamid Abaaoud**, **Salah Abdeslam**, **Brahim Abdeslam** and **Bilal Hadfi** were found in the apartment in *Charleroi*. The **Bilal Hadfi**'s DNA was also found in the apartment in *Schaerbeek*, the same where **Salah Abdeslam** found refuge after the Paris attacks.

During the blitz of 15 March 2016, **Mohamed Belkaid** was killed in the apartment in *Forest*, while **Salah Abdeslam** and **Soufiane Ayari** escaped to an apartment in *Molenbeek* where they have been captured after three days on 18 March 2016.

For the sake of completeness is necessary to point out that there are other evidences which support the key role of the brothers **el-Bakraoui** and **Salah Abdeslam** within the network. Despite German intelligence has repeatedly denied

⁶ Initially, *Mohamed Belkaid* was wanted under the alias *Samir Bouzid* (Webb and Sutton 2016, 31).

⁷ *Soufiane Ayari* was also known with the alias of *Amine Choukri* and *Monir Ahmed Alaaj* (Webb and Sutton 2016, 16).

⁸ *Khalid el-Bakraoui* utilized the alias *Ibrahim* for renting the apartment in *Charleroi Maaroufi* (Webb and Sutton 2016, 10).

the news, different newspapers (Dearden 2016; Halkon 2016; The Guardian 2016) reported as **Salah Abdeslam** possessed documents about the *Juelich Research Center*⁹ and a nuclear waste storage center located near the Belgian border. In the same way, the brothers **el-Bakraoui** recorded about 10 hours of footage relating to the habits of Belgian nuclear program manager, probably with the aim to kidnap him to build a dirty bomb (Steinbuch 2016; Mullin 2016). Similarly, the logistical support of **Najim Laachraoui** emerged relating to the manufacture of the explosive belts used by suicide bombers in the attacks in Paris and the explosives used in the Bruxelles attacks. In addition to this he rented the apartment in the town of *Auvelais* (Belgium) and his DNA was found by the authorities in the apartment in *Schaerbeek*. The important role played by **Najim Laachraoui** has also been revealed during the investigations about the terrorist attacks in Barcelona on 17 August 2017. As described above, the mastermind of the Barcelona attack named **Abdelbaki Es Satty** was directly trained by the Islamic State explosive expert called **Ahmad Alkhald Mohamad Siham**, the same explosives chief of the terrorist group that helped to carry out the attacks in Paris, November 2015, and Bruxelles, March 2016. In fact, as stated by the U.S State Department (2017) «Alkhald traveled to Europe, where he helped plan the Paris attacks and manufacture the explosive belts used in that plot [...]. Following his return to Syria shortly before the attacks in Paris, Alkhald continued to guide ISIS operatives in Europe on making the bombs used in the March 2016, Brussels attacks». As for **Abdelbaki Es Satty**, **Ahmad Alkhald Mohamad Siham** has directly provided technical guidance to **Najim Laachraoui** for the construction of suicide belts and explosives used during attacks (Orton 2017b), for this reasons **Najim Laachraoui** is a focal node within the network.

Finally, **Mohamed Abrini** is closely related to many of those who took part in the Paris attacks. First of all, he lived in the same neighborhood of **Abdelhamid Abaaoud** and was a close childhood friend of **Salah Abdeslam** (Webb and Sutton 2016, 13). The centrality of **Mohamed Abrini** is explained by the strong support to **Salah Abdeslam** during the planning. On November 11, 2015, **Mohamed Abrini** and **Salah Abdeslam** were filmed by a CCTV system in a gas station at *Ressons* in northern Paris (BBC News 2016b). Abrini's fingerprints have been found in two apartments rented in Belgium and inside the car used during attacks in Paris¹⁰. Despite he didn't complete the martyrdom operation within the *Zaventem* airport in Brussels, the figure of **Mohamed Abrini** is central for the logistical support related to both attacks in Paris and in Brussels.

⁹ For more details about the research center *Forschungszentrum Jülich GmbH* see: http://www.fz-juelich.de/portal/DE/Home/home_node.html.

¹⁰ *Ibidem*.

In conclusion, from the analysis of Paris-Brussels network emerged many elements that help to delineate the first network features related its structure (C2 of the operations) behind the attacks. Given the complexity and the amount of information obtained from the cross-analysis between social network analysis and the information obtained from the OSINT process, to clarify the key points are summarized below:

- The key actors within the Paris-Brussels network who assume a brokering role (high-betweenness centrality) and the role of leader (high-degree centrality) are **Abdelhamid Abaaoud, Salah Abdeslam, Khalid El-Bakraoui, Ibrahim el-Bakraoui, Mohamed Abrini, Najim Laachraoui**;
- Key actors presented have been associated with the role of operational coordinators (*general* and *logistical coordination*);
- From the analysis of the structure of network Paris-Brussels it has emerged a centralized network where the power and leadership positions are held by few actors (*i.e.* coordinators); the centralization indices related to centrality measures (*i.e.*, degree, betweenness, closeness) highlight a moderate amount of concentration and hierarchy in the network as whole.

4. Analysis of *Paris-Brussels* terrorist group in relation to the jihadist peripheral networks

4.1 Strategic analysis: Introduction to the jihadist peripheral networks

After the analysis of network Paris-Brussels the respective peripheral network have been considered. The main goal was to reduce the limits related to the use of the SNA as already shown above. The *incompleteness of the data* and the *network dynamics*. The introduction in the analysis of complementary actors involved in Paris and Brussels attacks offers a wider analytical view.

Morselli, Giguère and Petit (2006) during the analysis of Krebs' work (2002) outlined that the marginal actors are important within a network linked to terrorist activities, indeed their considerations allow to increment the accuracy of the analysis. Additional actors with an indirect role, highlighted the major actors in the network. This is shown by the changes of density and centrality measures from a *tactical terrorist networks* (*i.e.*, network directly implicated in the attacks) to *strategic terrorist network* (*i.e.*, tactical network and complementary networks). A density decrease is expected in relation to an increase of number of nodes, on the other hand, this leads to an increase in the level of centralization.

We try to clarify how metrics and influence of key players could vary considering the peripheral network.

4.2 Social network analysis of Paris-Brussels terrorist group in relation to the jihadist peripheral networks

The figure 11 shows the overall network composed by Paris-Brussels tactical terrorist network and the extremist peripheral groups. The overall network is composed by 202 actors which are the protagonists of events between 2012 and 2015 (with exception of *Toulouse-Artigat* network that is more dated). The Table 9 shows the topographical features of the overall network, specifically the metrics about the cohesion of overall network. The density score is 0.025, therefore only 2.5% of the possible ties within the overall network are present. This result reflects that very few actors have advantage positions, due to the possess the majority of ties in the network. It can be considered obvious that with the expansion of the Paris-Brussels network the density decreased from 0.097 to 0.025. Actually, the comparison of the two density scores does not provide us with useful information. As pointed out by Borgatti, Everett and Johnson (2013), more attention should be taken when density scores of small networks is compared with density scores of much larger networks. Indeed, density scores often are lower in large networks respect small networks because the measure of density is inversely related to network size. In this way, it has been considered the average degree of the network which is simply the average number of ties that each node within the network has (Everton 2012; Cunningham, Everton, and Murphy 2016). Compared to the Paris-Brussels graph the overall network has a lower score of average degree, this means that the entire network is less dense than the first

Table 9 - *Network cohesion Paris-Brussels group + jihadist peripheral networks*

<i>Network cohesion</i>	<i>Paris-Brussels group + jihadist peripheral networks</i>
Nodes	202
Density	0.025
Average number of contacts for each node	5
Average value of geodetic distances	4.2

The Table 10 shows the degree centrality scores about the firsts ten actors with a high-degree values (*nDegree*). **Abdelhamid Abaaoud** emerged as the most focal node in the overall network with a value of 20.4% (*nDegree*=0.20398), while **Salah Abdeslam** emerged as the second focal node with a score of 13.4% (*nDegree*=0.13443). To follow, **Khalid Zerkani** with a value of 11.4% (*nDegree*=0.11443); **Khalid el-Bakraoui** with 9.5% (*nDegree*=0.09453); **Foued Mohamed Aggad** with 9% (*nDegree*=0.08995); **Fabi-**

en **Clain** and **Chérif Kouachi**, 8% ($nDegree=0.07960$ and 0.079463); finally, **Chakib Akrouh**, **Salim Benghalem** and **Najim Laachraoui**, 7% ($nDegree=0.06965$).

Table 10 - *Degree centrality: Paris-Brussels group + jihadist peripheral networks*

<i>Rank</i>	<i>Nodes</i>	<i>Degree</i>	<i>nDegree</i>
1	Abdelhamid Abaaoud	0.204	41
2	Salim Benghalem	0.13433	27
3	Khalid Zerkani	0.11443	23
4	Khalid al-Bakraoui	0.09453	19
5	Foued Mohamed Aggad	0.08955	18
6	Fabien Clain	0.07960	16
7	Chérif Kouachi	0.07463	15
8	Chakib Akrouh	0.06965	14
9	Salim Benghalem	0.06965	14
10	Najim Laachraoui	0.06965	14

Concerning the overall distribution of betweenness centrality, the Table 11 shows the first ten actors with a high-betweenness score (*nBetweenness*), where the value of *Betweenness* refers to the extent to which a node lies on paths between other nodes, instead the normalized value – *nBetweenness* – is an adjusted percentage for network size. In this way, the first nodes with high betweenness represent the actors with a considerable influence within a network in relation to their control over the flows information. In this case too, **Abdelhamid Abaaoud** is the most influent node within the network ($nBetweenness=64\%$), after this in order: **Mehdi Nemmouche** ($nBetweenness=24\%$); **Salim Benghalem** ($nBetweenness=22\%$); **Fabien Clain** ($nBetweenness=19\%$); **Foued Mohamed Aggad** ($nBetweenness=16\%$); **Khalid Zerkani** ($nBetweenness=14.6\%$); **Salah Abdeslam** ($nBetweenness=10.5\%$); **Khalid el-Bakraoui** ($nBetweenness=8.05\%$) **Fares Mourad** ($nBetweenness=7.7\%$) and **Sid Ahmed Ghlam** ($nBetweenness=7.6\%$).

Table 11 - *Betweenness centrality: Paris-Brussels group + jihadist peripheral networks*

<i>Rank</i>	<i>Nodes</i>	<i>Degree</i>	<i>nDegree</i>
1	Abdelhamid Abaaoud	12846.355	63.912
2	Mehdi Nemmouche	4820.031	23.980
3	Salim Benghalem	4505.881	22.417
4	Fabien Clain	3818.483	18.997
5	Foued Mohamed Aggad	3233.744	16.008
6	Khalid Zerkani	2939.015	14.622
7	Salah Abdeslam	2105.157	10.473
8	Khalid el-Bakraoui	1618.712	8.053
9	Fares Mourad	1549.000	7.706
10	Sid Ahmed Ghلام	1534.469	7.634

Finally, it has been calculated the SNA metrics of centralization which describe the extent of the overall network centers over a few number of nodes (Table 12). The betweenness centralization index of 62.63% is very high, suggesting thus few nodes hold a wide power related to the intermediary positions. On the same way, the closeness centralization index of 36%, this score indicates that there is a moderate homogeneous dispersion of closeness centrality between actors.

On the other side, the degree centralization index of 18% is very low, this score suggests that there are an almost equality of influence within network, or is better to say, an equality in the connectivity, because the interactions between nodes are homogenous (score closer to zero).

Summarizing, the analysis of centralization indices in relation to the overall network composed by Paris-Brussels group and the jihadist peripheral networks, show mixed scores. In terms of betweenness (62.63%) and closeness (36%) the network's centralization is rather high, while in terms of degree centrality (18%) the network's centralization is very low.

After that, the interpretation about network's structure is very important, in fact with these different scores of centralizations the network appears to be not extremely hierarchy and nor a full-connected organization but a mix of the two.

Table 12 - *Centralization indices: Paris-Brussels group + jihadist peripheral networks*

<i>Centralisation indices</i>	<i>Score</i>	<i>Percentage</i>
Degree Centrality	0.18	18
Betweenness Centrality	0.6263	62.63
Closeness Centrality	0.3588	35.88

4.3 Analysis of the strategic-operational terrorist network: *Closeness centrality*

As stated before, the purpose of studying the Paris-Brussels terrorist group with the aggregation of jihadist peripheral networks considers additionally two main focal points: firstly, the dynamism of the network itself and its changes within a larger range of time and secondly the incomplete data related to the connections and actors in the network.

In this way, the double analysis related to the level of action: *tactical* and *strategic-operational* level can be considered a valid evaluation. Indeed, the analysis of tactical terrorist network highlighted the actors with a key role: the executors of the attacks and the related coordinators. Some of them were identified also as strategic-operational players supported by the strategical analysis.

The strategical analysis differs from tactical analysis in the choice of premises.

The tactical social network analysis is based on the actors with high scores of degree and betweenness centrality. The tactical network is constituted of the executors of attacks. Among them we have assumed that individuals who coordinated the attacks are required to have a lot of connections (leader figures) and to control the information flow (brokering role). In this way, within the Paris-Brussels network, the coordinating role has been associated to actors with high scores of *degree* and *betweenness* centrality (as said previously: Coordinator = Leader + Gatekeeper).

First of all, to analyze the behavior of the nodes related to the coordinating role within Paris-Bruxelles network, the centrality measures of the overall network before and after the introduction of jihadist peripheral networks has been compared. Table 13 shows the comparison of the respective degree and betweenness centrality related to the tactical (Paris-Bruxelles network) and strategic-operational analysis (Paris-Bruxelles + jihadist peripheral networks). Only **Abdelhamid Abaaoud** presents high scores of degree and betweenness both in tactical and strategic-operational analysis. Specifically, **Abdelhamid Abaaoud** shows a strong increase of betweenness centrality from tactical to

strategic-operational dimensions ($n_{\text{Betweenness}}=31 \rightarrow 64$), while the other actors show a relevant decrease of measures of different intensity.

Table 13 - *Degree and betweenness comparison between tactical and strategical dimensions*

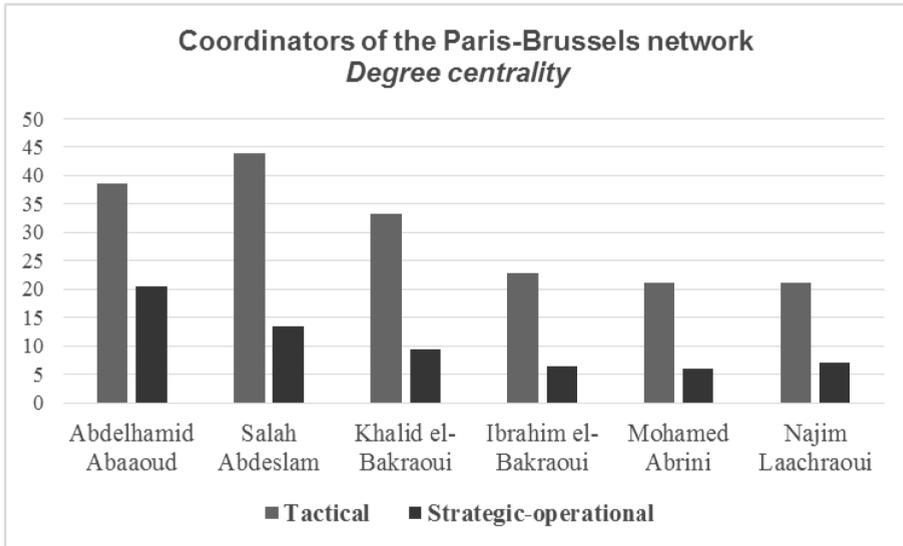
Coordinators	Tactical Analysis Paris-Brussels network		Strategic Analysis Paris-Brussels+jihadist peripheral networks	
	$n_{\text{Degree}} \%$ (rank) ¹¹	$n_{\text{Betweenness}} \%$ (rank)	$n_{\text{Degree}} \%$ (rank) ¹²	$n_{\text{Betweenness}} \%$ (rank)
Abdelhamid Abaaoud	38.596 (1)	30.796 (2)	20.40 (1)	63.912 (1)
Salah Abdeslam	43.860 (2)	31.231 (1)	13.43 (2)	10.473 (7)
Khalid el-Bakraoui	33.333 (3)	25.222 (3)	9.453 (4)	8.053 (8)
Ibrahim el-Bakraoui	22.807 (4)	10.466 (5)	6.468 (9)	3.819 (21)
Mohamed Abrini	21.053 (5)	14.882 (4)	5.970 (10)	4.572 (19)
Najim Laachraoui	21.053 (5)	6.553 (8)	6.965 (8)	6.638 (14)

The two diagrams (graph 1 and 2) presented below, report for each coordinator the change in the respective degree and betweenness measures. These results confirm the purely tactical coordinating role for the actors within Paris-Brussels network, except **Abdelhamid Abaaoud** who present a tactical-operational coordinating role. This is also confirmed by the descriptive information available from open sources. **Abdelhamid Abaaoud** started his command role with the network of Verviers operating from Turkey and later from Greece. In this way, Brisard and Jackson (2016) have pointed out as **Abdelhamid Abaaoud** was «a leading figure in this French-Belgian network, directly supervising the deployment from Syria and reception in Western Europe of the Verviers Islamic State team attack, as well as providing them with operational guidance. Unable to return to Belgium, Abaaoud maintained extensive communications with his accomplices there and played a *central* and *dominant role* in coordinating the Verviers cell's activities, from operational security issues to division of labor [...]» (3). On the same way, Daveed Gartenstein-Ross (2016) has confirmed the importance of **Abdelhamid Abaaoud** in the role of tactical commander for military operations outside the Syrian-Iraqi territory.

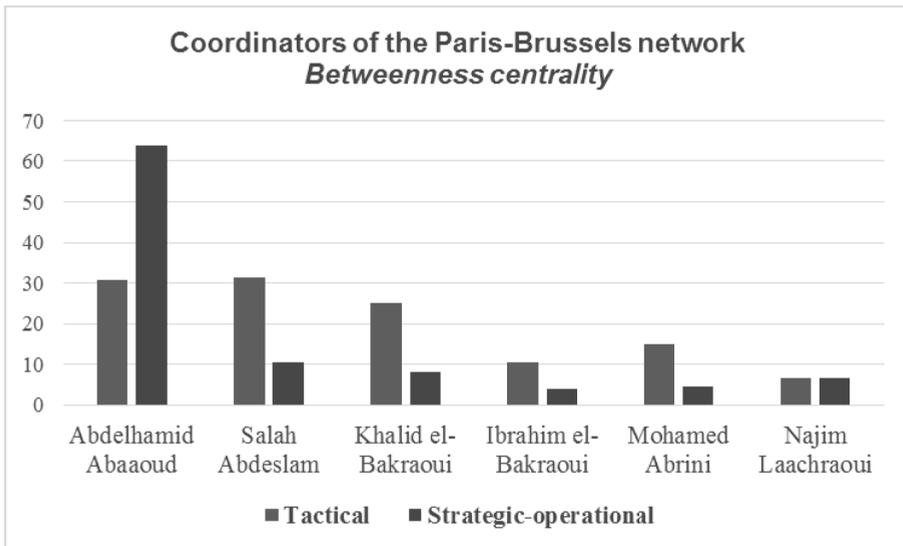
¹¹ Ranking based on the total nodes of the network (N=58).

¹² Ranking based on the total nodes of the network (N=202).

Graph 1



Graph 2



Confirmed the coordinating role of Abdelhamid Abaaoud in relation to the planning of terrorist attacks, who are the other relevant actors?

As stated before, the premises assumed for tactical analysis, tend to change if we want to operate within a strategic-operational dimension of the planning. Although nodes, with high scores of degrees and betweenness centrality

remain relevant, it is necessary consider more relevant the actors who have a considerable score of betweenness centrality, without necessarily having high scores of degree centrality. In other words, considering a strategic-operational level we can assume that «members with high betweenness, hold special interest for terrorist experts because gatekeepers are usually the contact person between several terrorist groups and play important roles in coordinating terrorist attacks» (Qin et al. 2005, 294). In addition to Abdelhamid Abaaoud the nodes with significant values of betweenness centrality are presented below:

- Mehdi Nemmouche;
- Salim Benghalem;
- Fabien Clain;
- Foued Mohamed Aggad;
- Khalid Zerkani;
- Salah Abdeslam;
- Khalid el-Bakraoui;
- Fares Mourad;
- Sid Ahmed Ghlam.

Abdelhamid Abaaoud, Mehdi Nemmouche and Salim Benghalem are closely linked each other. Salim Benghalem has been described by open sources as one of the top French recruiter and planner of Paris attacks above Abdelhamid Abaaoud (Webb and Sutton 2016). Additionally, their relevance within the ranks of the self-proclaimed ISIS emerges from other evidences. Salim Benghalem known Mehdi Nemmouche in Syria, when they both were jailers of four French hostages: Didier Francois, Edouard Elias, Pierre Torres e Nicolas Henin. They were detained in Aleppo between July and December 2013. Nicolas Henin, after his release, asserted that from observation of the relationships between the jailers, Salim Benghalem possessed a superior rank (BBC News 2016a). On February 9, 2015, Salim Benghalem appeared in a videotape titled “*From Inside Halab*” published by the media branch al-Hayat Media Center, where the French recruiter Salim Benghalem was interviewed by British journalist and hostage John Cantlie. In this videotape, the French recruiter exalted the jihad, inciting other Muslims to defend their religion becoming lone attackers (MEMRI TV 2015).

According to open sources, Salim Benghalem has been associated with a coordinating role in the Paris attacks, for instance Daveed Gartenstein-Ross (2016) highlighted Salim Benghalem as the “commander of Europe” who would have the task of overseeing tactical commanders like Abdelhamid Abaaoud. Strategic-operational social network analysis shows for Salim Benghalem a high score of betweenness centrality, then this value represents an

indication of how this actor was central in relation to the ability to handle the information and resources, such as foreign fighters.

In this way, we could assert that Salim Beghalem was not a fundamental representative to the operation – as Commander of Europe – but he was probably a logistical representative in relation to the Paris terrorist attacks. Starting from the Val-de-Marne network, which gravitated around Salim Beghalem, it is very likely that he continued the recruitment of jihadists taking vantage of his influence and contacts spread across the French territory. In this way the self-proclaimed Islamic State guaranteed a predominant position at Sam Beghalem for his strong ties with French radical networks. Based on these observations, it is very likely that Salim Beghalem was a **logistical connector** – a **recruiting bridge** – between the tactical-operational coordination (possessed by Abdelhamid Abaaoud) and strategic-operational coordination. In any case, we could exclude the role of European coordinator of attacks by Salim Beghalem.

In addition to Salim Beghalem, Fabien Clain has presented a high score of betweenness centrality. The open sources have emphasized the possibility that Abdelhamid Abaaoud was replaced after his death by Fabien Clain, in fact his voice has been recognized in the audiotape that claimed the Paris terrorist attacks (Webb and Sutton 2016; Gartenstein-Ross 2016). It is clear how to be a spokesman of so-proclaimed Islamic State is different than holding a coordinating role. On the same way of Salim Beghalem, Fabien Clain was specifically a recruiter. After converting to Islamic religion when he was 18, in 2000 he moved to Toulouse in France, becoming one of the leaders of the local Salafite movement.

In Toulouse Fabien Clain knows Mohamed Merah on whom he exerts a strong influence and indoctrination (Piquet 2016).

Three years later, on March 11, 2012, Mohamed Merah killed a French soldier. Four days later in *Montauban* he opened fire against a group of soldiers. On March 19, the same year, he attacked the Jewish school in Toulouse killing three people and injuring others. Few days later, Mohamed Merah was killed by the authorities during the blitz in his home in Toulouse (Le Parisien 2015a).

Ultimately, although some open sources have described the significant role of Fabien Clain within the self-appointed Islamic State there are no evidence that he has somehow directed the attacks in Europe. It would be more appropriate he had a role of recruitment of Syrian fighters throughout the french hubs known by Clain himself.

This aspect has indirectly emerged from the terrorist attack perpetrated by **Larossi Abballa** on 13 June 2016. Investigations in fact revealed that Abballa

was led by **Rachid Kassim** through the instant messaging application Telegram (Magazine Marianne 2016).

In addition, it also emerged that Fabien Clain's email address had been found in possession of a relative of Larossi Abballa. Clain's omnipresence within the French jihadist network finds a more concise explanation of the facts if we consider Fabien Clain as a recruiter. Into the Fabien Clain's most recent sightings was with his brother Jean-Michel Clain in mid-2016. These would appear to be non-active in the fight, they have built a community along with various Toulouse knowledge among which there is brother of Mohamed Merah (France Inter 2016).

Fares Mourad has a considerable value of betweenness centrality in relation to the *Strasbourg network*. He also played a major role as a recruiter, although he was not in connection with the attacks in Paris and Brussels, Mourad was already jailed in 2014 on his return from Syria because he was one of the main recruiters of young French foreign fighters (Boutry and Selami 2016).

As far as the central position of **Mehdi Nemmouche** and **Foued Mohammed Aggad** is related to their double link between the Paris network and the Strasbourg network. In fact, from the available information it is possible to state with certainty that their role was only marginal and only related to the execution of the related attacks. The same dynamics includes the position of **Sid Ahmed Glam**, in fact he was arrested on April 19, 2015 while he was perpetrating an attack on a church in Villejuif (Val-de-Marne) (L'Express 2016).

Below the representation (Figure 7) of the betweenness centrality along the y-axis. The representation provides a greater perception of the position and roles of the various actors in relation to the Paris and Brussels attacks.

Within the large network (Paris-Brussels network + peripheral networks) we were asked not only what actors played the role of *gatekeeper*, in other words the actors who have the ability to filter the information and resources, but also which actors would be able to convey information and resources in a quick and varied way. For this reason, within the strategic analysis, in addition to betweenness it has been calculated the *closeness centrality*. In according to Wasserman and Faust (1994) the metric focuses on how *close* an actor is central if it can quickly interact with all others, in this way is possible to affirm «nodes with greater closeness are connected to more individuals. They are rapid disseminators of information and other communications [...]» (Duval, Christensen, and Spahiu 2010, 4).

Table 14 shows for the overall network the nodes with high scores of closeness centrality, the range of oscillation between each actor is very small.

Figure 7 - *Pyramidal representation of the positions of the actors – Betweenness centrality*

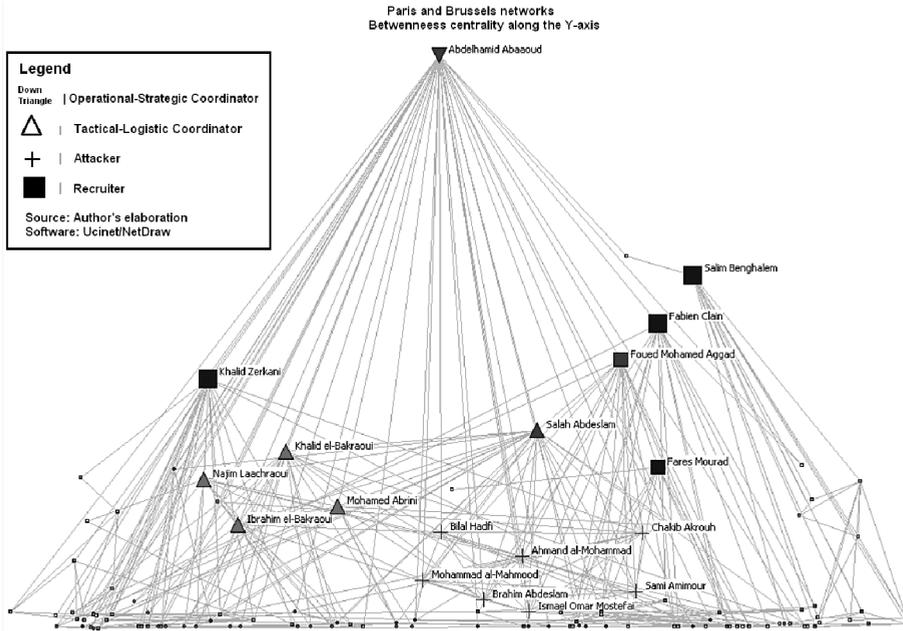


Table 14 - *Closeness centrality: Paris-Brussels network + jihadist peripheral networks*

Rank	Nodes	nCloseness
1	Abdelhamid Abaaoud	42.675
2	Salah Abdeslam	35.378
3	Khalid Zerkani	34.447
4	Chakib Akrouh	34.010
5	Mehdi Nemmouche	33.333
6	Fatima Aberkan	33.278
7	Sid Ahmed Ghlam	33.223
8	Ahmad al-Mohammad	33.168
9	Mohammad al-Mahmood	33.168
10	Brahim Abdeslam	33.168
11	Foued Mohamed Aggad	33.114
12	Fabien Clain	33.059
13	Bilal Hadfi	33.005
14	Ibrahim el-Bakraoui	32.897

15	Mohamed Abrini	32.790
16	Khalid el-Bakraoui	32.630
17	Lazez Abraimi	32.315
18	Sami Amimour	32.212
19	Ismael Omar Mostefai	32.212
20	Nourredine Abraimi	32.006

4.4 Final analysis of the strategic-operational terrorist network: Structural holes, roles, positions of the actors

This study set out to utilize the social network analysis in order to clarify the structure and organizational characteristics of overall network behind the Paris and Brussels terrorist attacks. Considering the tactical and strategic social network analysis utilized in this paper, the related considerations can be summarized as follows. The global centrality shows two important structural characteristics. The structural level of hierarchy is moderate at the tactical level, in other words there is a moderate centralization in the tactical network, while at the strategic level the global centrality has shown a mixed result. The overall network composed by Paris-Brussels and the peripheral networks has shown that the interactions between nodes are homogenous in terms of connectivity between the actors (low score for degree centralization). At the same time the high score of betweenness centralization shows a high level of structural constraints between nodes, thus only few nodes hold a wide power assuming the position of gatekeepers within the overall network. Finally, the relevant score for closeness centralization has highlighted the presence of few key nodes which are connected to more individuals, then they can achieve very quickly other actors to spread information and resources in different ways.

From a communication point of view considering the closeness and betweenness centralization indices the overall network tends to a *hierarchy structure*, there were few actors who hold the management power of information and resources in relation to the planning of the attacks. Although the presence of a low score of degree centralization index could indicate that no actors influence and dominate all other nodes, became necessary pay attention to interpret that index. Indeed, the centralization indices provide information in structural terms, thus not necessarily, the homologation in terms of connectivity coincides with the presence of the same capacity for influence among the network actors. In this way, it is possible to speak in terms of *hybrid structure*, where from the structural point of view the organizational form of the group behind the terrorist attacks in Paris and Brussels is a *networked*

structure strictly speaking, or we can also consider this in terms of *reticular structure*. In the same time, within this reticular structure a *hierarchical decision-making and management structure* is set up as deduced by betweenness and closeness centralization indices scores.

More specifically, through the analysis of the local centrality were identified the actors who composed the central hub and led the terrorist attacks. **Abdelhamid Abaaoud** can be defined as *tactical-operational coordinator* of the Paris-Brussels attacks, in fact he scores a high degree and betweenness centrality in the tactical analysis and highest score for degree and betweenness centrality in the strategic analysis. He also scores highest for closeness centrality, which shows that he is the actor who had the best capacity of reaching a large quantity of supporter in the net. At the same time, the *tactical central hub* was formed by **Salah Abdeslam, Khalid el-Bakraoui, Ibrahim el-Bakraoui, Najim Laachraoui, Mohamed Abrini**, although they maintain a relevant importance, their degree and betweenness scores decrease in relation to the strategic analysis, showing how their coordinating function was limited to the tactical dimension of the attacks.

As previously explained, to reinforce these considerations we have analyzed the structural holes in relation to the Paris-Brussels network and the peripheral networks.

Table 15 - *Structural holes measures of the Paris-Brussels network + jihadist peripheral network*

<i>Nodes</i>	<i>EffSize</i>	<i>Efficiency</i>	<i>Constraint</i>	<i>Hierarchy</i>
Abdelhamid Abaaoud	36.268	0.885	0.076	0.033
Khalid Zerkani	20.217	0.879	0.122	0.059
Salah Abdeslam	21.593	0.800	0.123	0.039
Khalid el-Bakraoui	15.526	0.817	0.168	0.103
Najim Laachraoui	11.857	0.874	0.186	0.105
Foued Mohamed Aggad	10.889	0.605	0.189	0.007
Fabien Clain	12.500	0.781	0.206	0.085
Salim Benghalem	10.714	0.765	0.222	0.058
Mohamed Abrini	9167	0.764	0.232	0.068
Chakib Akrouh	7.714	0.551	0.250	0.048
Ibrahim el-Bakraoui	8.538	0.657	0.254	0.070
Bilal Hadfi	6.231	0.479	0.261	0.018
Mohammad al-Mahmood	4.833	0.403	0.299	0.035

Ahmad al-Mohammad	4.833	0.404	0.299	0.035
Brahim Abdeslam	4.167	0.347	0.300	0.017
Fares Mourad	4.200	0.420	0.321	0.036
Sami Amimour	2.600	0.260	0.351	0.020
Ismael Omar Mostefai	2.600	0.260	0.351	0.020

The table 15 shows the relative measures of the structural holes about the overall network. The nodes have been ranked according to *Constraint* value, the actor with a lower score of constraint is precisely **Abdelhamid Abaaoud** ($C_s=0.076$) which is also associated with the highest value of *Efficiency* ($E_f=0.885$). This result points out the key role of Abaaoud relating to the coordination of resources, information and the exercise of power over one's neighborhood. On the contrary, actors who have directly perpetrated the attacks in Paris on 13 November 2015, show the highest value of *Constraint* and then low scores of *Efficiency*. In order to achieve a greater understanding, are reported in the table 16 the metrics regarding the main actors are in relation to the C2, with the associated role (coordinator, logistical coordinator, recruiter and attacker) and the dimension in which actors operated (*i.e.*, strategic, operational and tactical dimension) in the Paris and Brussels attacks planning.

Table 16 - *Dimensions, roles and metrics about key nodes of the network*

<i>Nodes</i>	<i>Dimension</i>	<i>Role</i> ¹³	<i>nDegree</i>	<i>nBetween-ness</i>	<i>nClose-ness</i>
Abdelhamid Abaaoud	Strategic-operational	General coordinator	20.40	63.912	42.675
Salah Abdeslam	Tactical-operational	Logistical coordinator*	13.43	10.473	35.378
Khalid el-Bakraoui	Tactical-operational	Logistical coordinator*	9.453	8.053	32.630
Ibrahim el-Bakraoui	Tactical-operational	Logistical coordinator*	6.468	3.819	32.897
Najim Laachraoui	Tactical-operational	Logistical coordinator*	6.965	6.638	31
Mohamed Abrini	Tactical	Logistical coordinator *	5.970	4.572	32.790

¹³ Asterisk identifies those actors who were also attacker.

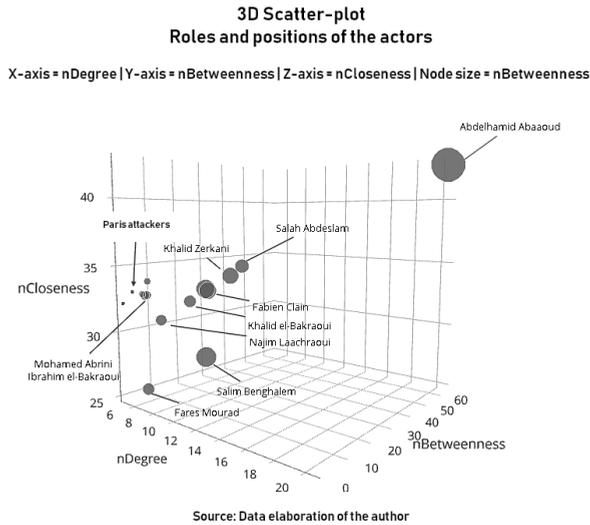
Foued Mohamed Aggad	Tactical	Attacker	8.955	16.088	33.114
Chakib Akrou	Tactical	Attacker	6.965	2.570	34.010
Bilal Hadfi	Tactical	Attacker	6.468	2.376	33.005
Mohammad al-Mahmood	Tactical	Attacker	5.970	0.790	33.168
Brahim Abdeslam	Tactical	Attacker	5.970	0.616	33.168
Ismail Omar Mostefai	Tactical	Attacker	4.975	0.495	32.212
Sami Amimour	Tactical	Attacker	4.975	0.495	32.212
Ahmad al-Mohammad	Tactical	Attacker	5.970	0.790	33.168
Salim Benghalem	Strategic-operational	Recruiter	6.965	22.417	27.199
Fabien Clain	Tactical-operational	Recruiter	7.960	18.997	33.059
Khalid Zerkani	Tactical	Recruiter	11.443	14.622	34.447
Fares Mourad	Tactical-operational	Recruiter	4.975	7.706	25.703

Finally, a 3d scatter-plot (Graph 3) has been developed with the aim to show the metrics on the different axis ($x = nDegree$, $y = nBetweenness$, $z = nCloseness$) related to the actors listed in the table 16. This visualization method emerged very useful to visualize the command and control chain; infact it can be observed which actor assumed the role of general coordinator (**Abdelhamid Abaaoud**) tends a position towards the upper right corner of the space. On the contrary, when the actor has a role associated with the tactical dimension he tends to the position towards the lower left corner. The actors who are less subject to this logic are **Salim Benghalem** and **Fares Mourad**, however their position in the space is related to their minimal roles in the planning of Paris and Brussels attacks. On the same way, **Khalid Zerkani** and **Fabien Clain** have a relevant position in the scatter plot. Although they did not participate directly in the planning of the terrorist attacks, during the years their work in terms of recruitment has been so remarkable to influence in a preponderant way the real possibility of implementation of future Paris and Brussels attacks. For last, **Foued Mohammed Aggad** has been considered into the scatter-plot as outlier in relation to his participation in both the Strasbourg cell and the Paris-Brussels network.

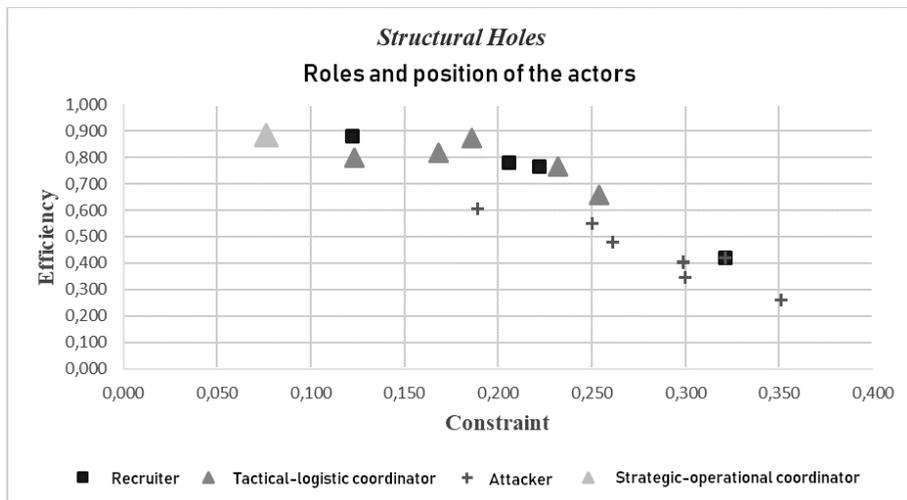
In conclusion, it has been represented another scatter-plot (Graph 4) related to the *structural holes' analysis*, where on X-axis is reported the *Constraint* while on the Y-axis is reported the *Efficiency* (the actors are differentiated in relation to the associated roles).

Paris-Brussels network with the relative peripheral networks in relation to the *degree* and *betweenness* centralities are reported below in figures 9 and 10.

Graph 3 - 3D Scatter-plot related to roles and positions of the actors



Graph 4 - *Structural holes* – Role and position of the nodes

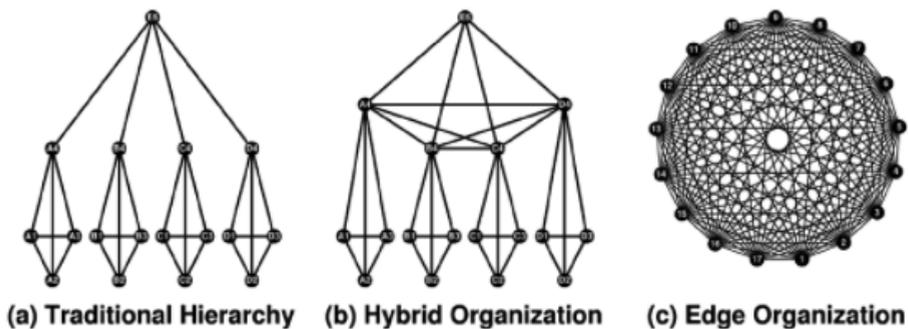


5. Conclusions, limitations and perspective

This study has analyzed the *morphologic* and *functional* structure of the network related to the Paris-Brussel terrorist attacks. Utilizing the social network analysis has been possible to highlight the key actors within the network and their related roles. After that, considering the marginal networks which during the years gravitated around the Paris-Brussels group, it has been possible to delineate the overall structure of the jihadist network related to ISIS and the Paris-Brussels network's behavior within a strategic vision (Paris-Brussels group with the peripheral networks) in addition to the tactical dimension (Paris-Brussels group). In this way, the **H2** e **H3** hypotheses concerning the usefulness of local and global centrality measures for the study of functional and morphological structure has been amply corroborated.

On one side, the local centrality measures underline the presence of a strict command and control chain within the tactical-operational dimension of planning with a *pyramidal functional structure* with a single general coordinator at the top and specific key positions below. The pyramidal functional structure refers to the presence of a *hierarchical decision-making structure* within the overall network. On other side, the global centrality highlighted that the network tends to a *reticular structure* and not a *pyramidal structure* strictly speaking. In this way, the analysis has shown the presence of a *reticular structure* tending to an «*edge organization*» (Alberts and Hayes 2005). Thus, the presence of a reticular structure with a centralized decision-making reflects the presence of a **hybrid structure**. The figure 8 shows some simple models of three different organization structures. The hybrid organization can be considered as a mix between the traditional hierarchical command and control and a full edge organization.

Figure 8



Firstly, the edge organization permits to increase the speed of the command function¹⁴ over a strong network grid. Moreover, within a networked structure, the connections do not move only from the top to bottom as in a traditional hierarchical command and control chain, but in all directions. Secondly, within this type of organizational structure the decision-making system is unitary and not a peer-to-peer system typical of fully-connected organizations.

In this way, this analysis permits to underline a crucial aspect of the studies about SNA. It is necessary differentiate between the functional analysis, which refers to the role analysis, the positional study of the nodes within the network (the determination of the key players) and how they relate to each other, and the *structural analysis* of an actor that refers to the *connectivity* between nodes and not necessarily the ability to influence and direct other nodes. In this sense, as asserted by Wasserman and Faust (1994), the connectivity is a measure of the cohesiveness of a graph. A graph is cohesive if there are frequent and numerous paths between pairs of nodes, however the connectivity does not provide any indication of the content of the relationship between two nodes, the direction of the relationship, or taking into account the analysis discussed here, the direction of the command function through the graph. Thus, the first hypothesis (**H1**) concerning the presence of a highly hierarchical and centralized network behind Paris and Brussels attacks was partially corroborated.

From the tactical-strategic analysis and the cross-analysis with open sources it has been possible to identify different actors and roles who conducted various activities.

As already pointed out, the strategic analysis allowed to verify the behavior of the nodes that emerged as focal points within the tactical analysis. In this way it was possible to consider the relevance of the actor and his role within both dimensions.

The considerations of peripheral networks have highlighted some actors who were just supporters subsequently they developed over time into key members in relation to the Paris-Brussel attacks. For example, the role of the *Zerkani cell* emerged as fundamental. In fact, *Khalid Zerkani* has recruited most of all actors who later participated in the planning and implementation of the Paris and Brussels attacks.

In conclusion, this research represents one of the few attempts to study the command and control (C2) related to a terrorist attack through social

¹⁴ The *command function* is generally defined as «the authority vested in an individual of the armed forces for the direction, coordination, and control of military forces» (Builder, Banks, and Nordin 1999, xiii).

network analysis. Moreover, it is one of the few studies that aims to investigate the jihadist network linked to ISIS through the SNA. The analysis of C2 is very important to understand the model of communication utilized within a terrorist network for visualizing different strategic options to fragment a terrorist group in the future. However, this study is not exempt from limitations. In according to V. Krebs (2002) the main limitations concern three problems to be consider to analyze a dark network. Firstly, the *fuzzy boundaries* concern the difficult of deciding who or not include in the network; secondly, there is always a problem of *incompleteness*, in other words the inevitability of missing nodes and connections that the researcher cannot know. Indeed, the main information about the graph are collected from open sources; thirdly, any graph usually is analyzed in its static form however the networks are *dynamic* and change continuously.

Furthermore, the definition of the roles is the cross-product of the analysis with the SNA but also a set of decisions on descriptive considerations of events and information available. It is evident that this research is based on the intersection of qualitative information processed by open sources and the quantitative data – the results of statistical analysis of networks-. This represents an added value but at the same time a sort of gray area.

Another data limitation is due to the inexistent information about direction, strength or nature of the ties. It is extremely useful to consider the weight of family ties of a terrorist network, indeed several recent terrorist attacks involved family members participating in the same tactical cells. For instance, in the Charlie Hebdo attack we had the brothers Saïd and Chérif Kouachi; in the Paris attacks we had the brothers Brahim and Salah Abdeslam; in the Brussels attacks we had the brothers Ibrahim and Khalid El Bakraoui, tied also with their cousin Osama Ahmad Mohammad Atar, a strategic coordinator. In earlier times, the Boston attack was perpetrated by Tsarnaev brothers, while the San Bernardino attack was perpetrated by Tashfeen Malik – Syed Rizwan Farook, wife and husband. In this perspective, the consideration of family ties could help to provide some “preventive” identification *drivers* to monitor other future plots.

In conclusion, for future researches the analysis of the command and control system (C2s) of terrorist organizations should be explored within the use of the SNA, especially in reference to terrorist attacks. SNA became a necessary method to understand the characteristics of a network. The entire master’s thesis of the author considers other methods to investigate C2, such as the NATO SAS-050 model and the N-Squared diagram. The exploration and crossing different studies on dark networks is fundamental to keep the monitoring on the evolution of terrorist organizations, therefore to better understand these organizations also in relation to counter-terrorism actions.

Figure 9 - Degree centrality: Paris-Brussels network + jihadist peripheral network

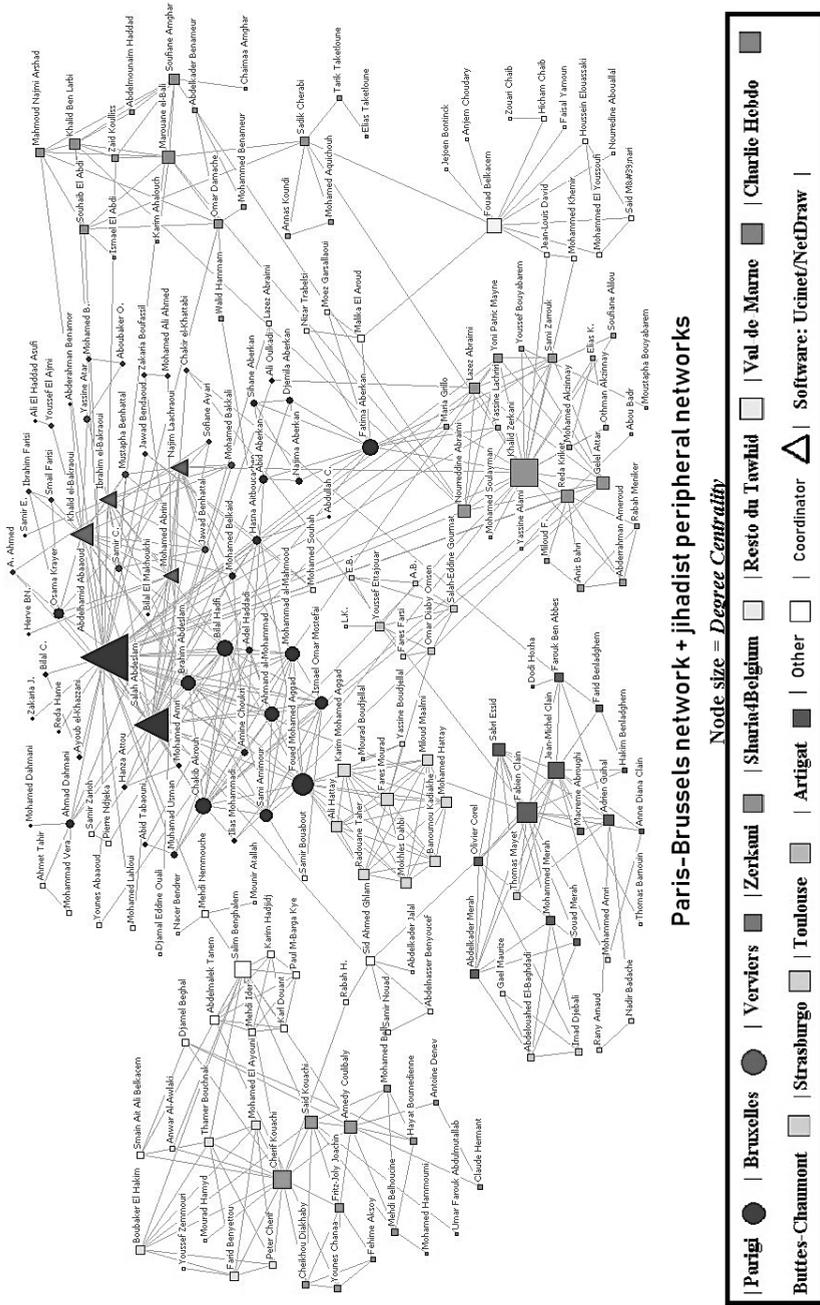
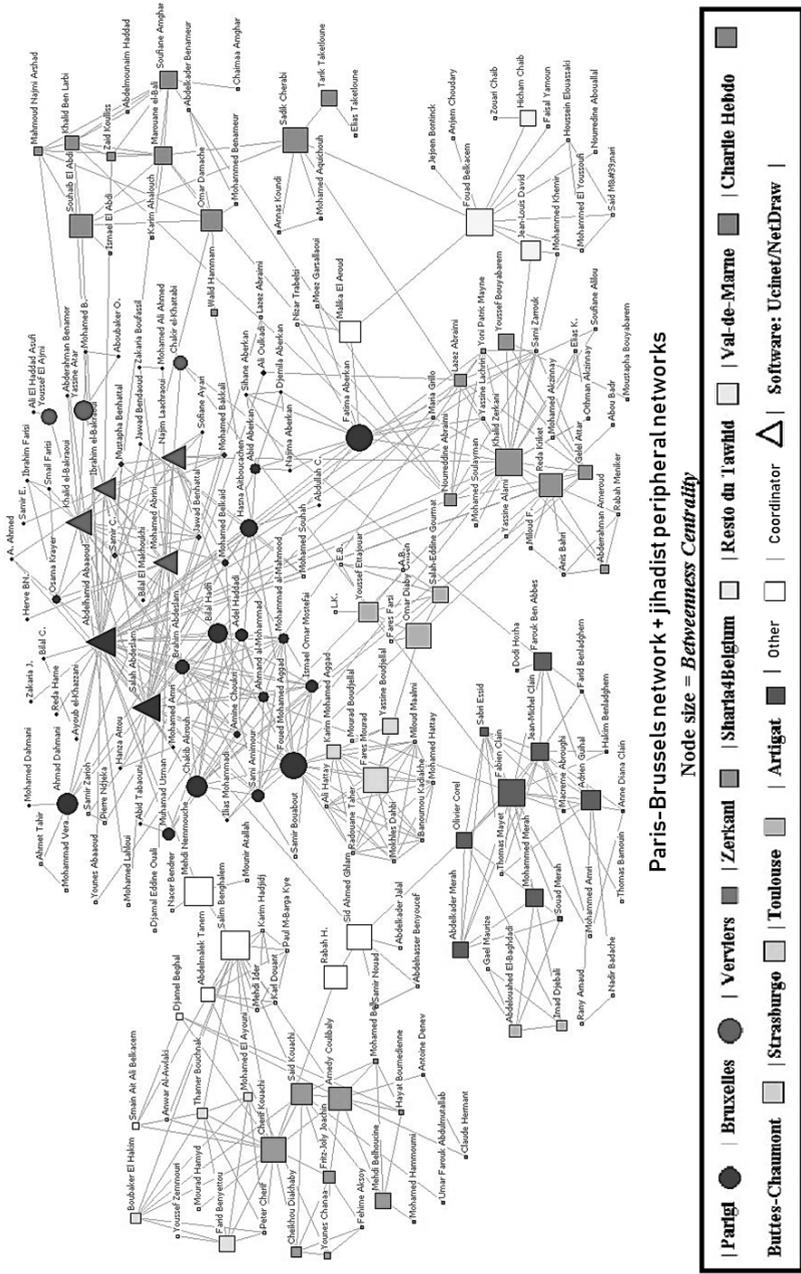


Figure 10 - Betweenness centrality: Paris-Brussels network + jihadist peripheral network



Bibliography

- Abraham, Ajith, and Aboul-Ella Hassanien. 2012. *Computational Social Networks: Tools, Perspectives and Applications*. Springer Science & Business Media.
- Alberts, D.S., and R.E. Hayes. 2005. "Power to the Edge: Command and Control in the Information Age." Washington DC: CCRP. http://www.dodccrp.org/files/Alberts_Power.pdf.
- Antony, Richard T. 2015. *Data Fusion Support to Activity-Based Intelligence*. Artech House.
- Asal, Victor H., Hyun Hee Park, R. Karl Rethemeyer, and Gary Ackerman. 2016. "With Friends Like These ... Why Terrorist Organizations Ally." *International Public Management Journal* 19 (1): 1–30. <https://doi.org/10.1080/10967494.2015.1027431>.
- Baber, Professor Chris, Professor Don Harris, and Professor Neville A. Stanton. 2012. *Modelling Command and Control: Event Analysis of Systemic Teamwork*. Ashgate Publishing, Ltd.
- Baum, Joel A.C., and Timothy J. Rowley. 2008. *Network Strategy*. Emerald Group Publishing.
- BBC News. 2016a. "Paris Attacks: Was Salim Benghalem the Real Ringleader?" *BBC News*, January 26, 2016, sec. Europe. <http://www.bbc.com/news/world-europe-35399021>.
- — —. 2016b. "Paris Attacks: Key Suspect Abrini Arrested in Brussels." *BBC News*, April 9, 2016, sec. Europe. <http://www.bbc.com/news/world-europe-36000407>.
- Berzinji, A., L. Kaati, and A. Rezine. 2012. "Detecting Key Players in Terrorist Networks." In *2012 European Intelligence and Security Informatics Conference*, 297–302. <https://doi.org/10.1109/EISIC.2012.13>.
- Bie, Jasper Lowie de. 2016. *How Jihadist Networks Operate: A Grounded Understanding of Changing Organizational Structures, Activities, and Involvement Mechanisms of Jihadist Networks in the Netherlands*. Leiden University, PhD Thesis.
- Borgatti, Stephen P., Martin G. Everett, and Jeffrey C. Johnson. 2013. *Analyzing Social Networks*. SAGE.
- Boutry, Timothy, and Stéphane Sellami. 2016. "Mourad Farès, Le Sergent Recruteur Du Djihad." *Leparisien.Fr*. June 12, 2016. <http://www.leparisien.fr/faits-divers/le-sergent-recruteur-du-djihad-12-06-2016-5875367.php>.
- Boztas, Senay, and David Chazan. 2016. "'Man in the Hat' Belgian Terror Suspect Mohamed Abrini 'Admitted He Took Photos of Football Stadium in Manchester.'" *The Telegraph*, July 4, 2016. <http://www.telegraph.co.uk/news/2016/07/04/man-in-the-hat-belgian-terror-suspect-mohamed-abrini-admitted-he/>.
- Brisard, Jean-Charles, and Kévin Jackson. 2016. "The Islamic State's External Operations and the French-Belgian Nexus." *CTC Sentinel | Combating Terrorism Center at West Point* 9 (11).
- Builder, Carl H., Steven C. Bankes, and Richard Nordin. 1999. "Command Concepts. A Theory Derived from the Practice of Command and Control." Rand Corporation. http://www.rand.org/pubs/monograph_reports/MR775.html.

- Burt, Ronald S. 2009. *Structural Holes: The Social Structure of Competition*. Harvard University Press.
- Calderoni, Francesco. 2014. "Identifying Mafia Bosses from Meeting Attendance." In *Networks and Network Analysis for Defence and Security*, 27–48. Lecture Notes in Social Networks. Springer, Cham. https://doi.org/10.1007/978-3-319-04147-6_2.
- Choudhary, Pankaj, and Upasna Singh. 2016. "Ranking Terrorist Nodes of 26/11 Mumbai Attack Using Analytical Hierarchy Process with Social Network Analysis." In , 46–51. Albany, NY: Albany.edu. http://www.albany.edu/iasymposium/proceedings/2016/12_Choudhary_Singh_ASIA2016.pdf.
- Council, National Research, Division of Behavioral and Social Sciences and Education, Board on Human-Systems Integration, and Committee on Human Factors. 2003. *Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers*. National Academies Press.
- Cunningham, Daniel, Sean Everton, and Philip Murphy. 2016. *Understanding Dark Networks: A Strategic Framework for the Use of Social Network Analysis*. Rowman & Littlefield.
- Dearden, Lizzie. 2016. "Paris Attacks Isis Suspect Salah Abdeslam Had Nuclear Files Stashed in His Flat." Independent. April 14, 2016. <http://www.independent.co.uk/news/world/europe/isis-nuclear-threat-documents-on-german-atomic-research-centre-found-at-salah-abdeslams-home-a6983831.html>.
- Degenne, Alain, and Michel Forsé. 1999. *Introducing Social Networks*. SAGE.
- Duval, Robert D., Kyle Christensen, and Arian Spahiu. 2010. "Bootstrapping a Terrorist Network." In . Paper 20. http://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1017&context=pnconfs_2010.
- Everton, Sean F. 2012. *Disrupting Dark Networks*. Cambridge University Press.
- France Inter. 2016. "Qui Est Fabien Clain, La Voix Française Du Groupe État Islamique ?" Franceinter.Fr. September 16, 2016. <https://www.franceinter.fr/emissions/l-enquete-de-secrets-d-info/l-enquete-de-secrets-d-info-16-septembre-2016>.
- Freeman, Linton C. 1979. "Centrality in Social Networks Conceptual Clarification." *Social Networks* 1: 215–39.
- Gartenstein-Ross, Daveed. 2016. "Radicalization in the U.S. and the Rise of Terrorism." In *United States House Committee on Oversight and Government Reform*. Washington, DC: House Committee on Oversight and Government Reform. <https://oversight.house.gov/wp-content/uploads/2016/09/Gartenstein-Ross-State-ment-Radicalization-9-14.pdf>.
- Gouda, Mohamed G., Sandeep S. Kulkarni, and Ehab S. Elmallah. 2007. "Logarithmic Keying of Communication Networks." In *Stabilization, Safety, and Security of Distributed Systems: 8th International Symposium, SSS 2006, Dallas, TX, USA, November 17-19, 2006, Proceedings*, edited by Ajoy K. Datta and Maria Gradinariu. Springer Science & Business Media.
- Grant, T.J. 2014. *Network Topology in Command and Control: Organization, Operation, and Evolution: Organization, Operation, and Evolution*. IGI Global.

- Halkon, Ruth. 2016. "Paris Attacks Suspect Had Papers about Nuclear Research Base Hidden in Flat." *Mirror*. April 14, 2016. <http://www.mirror.co.uk/news/world-news/paris-attacks-suspect-salah-abdeslam-7752354>.
- Hanna, Raymond Keith. 2009. "MILITARY ORGANIZATIONAL STRUCTURE CENTRALIZED VS DECENTRALIZED DECISION MAKING." Norman, Oklahoma: University of Oklahoma. https://www.academia.edu/4170952/MILITARY_ORGANIZATIONAL_STRUCTURE_CENTRALIZED_VS_DECENTRALIZED_DECISION_MAKING_THESIS.
- Hanneman, Robert A., and Mark Riddle. 2005. *Introduction to Social Network Methods*. Riverside, CA: University of California, Riverside. <http://faculty.ucr.edu/~hanneman/>.
- Jenkins, Dr Daniel P., Dr Guy H. Walker, Professor Neville A. Stanton, and Professor Paul M. Salmon. 2012. *Command and Control: The Sociotechnical Perspective*. Ashgate Publishing, Ltd.
- Koschade, Stuart. 2006. "A Social Network Analysis of Jemaah Islamiyah: The Applications to Counterterrorism and Intelligence." *Studies in Conflict & Terrorism* 29 (6): 559–75. <https://doi.org/10.1080/10576100600798418>.
- Krebs, V.E. 2002. "Mapping Networks of Terrorist Cells." *Connections* 24 (3): 43–52.
- Le Parisien. 2015a. "Mars 2012 : L'affaire Merah." *La Galaxie Djihadiste*. February 19, 2015. <http://atelier.leparisien.fr/galaxie-djihadiste/profil.php?id=E01>.
- — —. 2015b. "Attaque Dans Le Thalys : Ayoub El-Khazzani Mis En Examen et Écroué." *Leparisien.Fr*. August 25, 2015. <http://www.leparisien.fr/faits-divers/attaque-dans-le-thalys-ayoub-el-khazzani-disposait-de-270-munitions-25-08-2015-5034469.php>.
- Leavitt, Harold J. 1951. "Some Effects of Certain Communication Patterns on Group Performance." *The Journal of Abnormal and Social Psychology* 46 (1): 38–50. <https://doi.org/10.1037/h0057189>.
- — —. 1974. "Some Effects of Certain Communication Patterns on Group Performance." In *Human Communication: Core Readings*, edited by Nancy L. Harper. Ardent Media.
- L'Express. 2016. "Sid Ahmed Ghlam et l'attentat Déjoué de Villejuif." *L'Express.Fr*. March 17, 2016. http://www.lexpress.fr/actualite/societe/sid-ahmed-ghlam-et-l-attentat-dejoue-de-villejuif_1774257.html.
- Magazine Marianne. 2016. "Rachid Kassim, la dangereuse nounou des adolescents radicalisés sur Telegram." *Text. Marianne.net*. September 12, 2016. <http://www.marianne.net/rachid-kassim-dangereuse-nounou-adolescents-radicalises-telegram-100245720.html>.
- MEMRI TV. 2015. "Archival: British Hostage John Cantlie Interviews Top French ISIS Recruiter Salim Benghalem in ISIS Video." MEMRI – The Middle East Media Research Institute. February 8, 2015. <https://www.memri.org/tv/archival-british-hostage-john-cantlie-interviews-top-french-isis-recruiter-salim-benghalem-isis/transcript>.

- Morselli, Carlo, Katia Petit, and Cynthia Giguère. 2006. "The Efficiency/Security Trade-off in Criminal Networks." SSRN Scholarly Paper ID 945369. Rochester, NY: Social Science Research Network. <https://papers.ssrn.com/abstract=945369>.
- Mullin, Gemma. 2016. "Brussels Attacks Suicide Bombers Originally 'Targeted Nuclear Power Plants.'" *Mirror*. March 25, 2016. <http://www.mirror.co.uk/news/world-news/brussels-attacks-suicide-bombers-were-7625911>.
- Naveh, Shimon. 2013. *In Pursuit of Military Excellence: The Evolution of Operational Theory*. Routledge.
- Nooy, Wouter de, Andrej Mrvar, and Vladimir Batagelj. 2011. *Exploratory Social Network Analysis with Pajek*. Cambridge University Press.
- Orton, Kyle. 2017a. "Foreign Terrorist Attacks By The Islamic State, 2002-2016." Centre for the Response to Radicalisation and Terrorism (CRT) and Henry Jackson Society. <http://henryjacksonsociety.org/wp-content/uploads/2017/03/HSJ-ISIS-1.pdf>.
- — —. 2017b. "America Sanctions the Islamic State's Intelligence Chief." *Henry Jackson Society* (blog). September 3, 2017. <http://henryjacksonsociety.org/2017/09/03/america-sanctions-the-islamic-states-intelligence-chief/>.
- Piquet, Caroline. 2016. "La Lettre de Fabien Clain, 'Voix Française de Daech', à Mohammed Merah." *LCI*. September 16, 2016. <http://www.lci.fr/faits-divers/la-lettre-de-fabien-clain-a-mohammed-merah-2003263.html>.
- Qin, Jialun, Jennifer J. Xu, Daning Hu, Marc Sageman, and Hsinchun Chen. 2005. "Analyzing Terrorist Networks: A Case Study of the Global Salafi Jihad Network." In *Intelligence and Security Informatics*, edited by Paul Kantor, Gheorghe Muresan, Fred Roberts, Daniel D. Zeng, Fei-Yue Wang, Hsinchun Chen, and Ralph C. Merkle, 287–304. Lecture Notes in Computer Science. Springer Berlin Heidelberg. https://doi.org/10.1007/11427995_24.
- Reinares, Fernando, and Carola Garcia-Calvo. 2018. "'Spaniards, You Are Going to Suffer:' The Inside Story of the August 2017 Attacks in Barcelona and Cambrils." *CTC Sentinel | Combating Terrorism Center at West Point* 11 (11): 1–11.
- Ressler, Steve. 2006. "Social Network Analysis as an Approach to Combat Terrorism: Past, Present, and Future Research." *HOMELAND SECURITY AFFAIRS* (blog). July 1, 2006. <https://www.hsaj.org/articles/171>.
- Šabić, Senada Šelo, and Sonja Borić. 2016. "At the Gate of Europe. A Report on Refugees on the Western Balkan Route." Friedrich Ebert Stiftung. http://www.irmo.hr/wp-content/uploads/2016/05/At-the-Gate-of-Europe_WEB.pdf.
- Scott, John. 2012. *Social Network Analysis*. SAGE.
- Scott, John, and Peter J. Carrington. 2011. *The SAGE Handbook of Social Network Analysis*. SAGE.
- Shapiro, Jacob N. 2005. "Organizing Terror: Hierarchy and Networks in Covert Organizations," September. http://research.allacademic.com/meta/p_mla_apa_research_citation/0/4/0/6/8/p40688_index.html?phpsessid=jm0et6uh5ejm6hl6mp5a0amui6.

- Speckhard, Anne, and Ahmet S. Yayla. 2017. "The ISIS Emni: The Origins and Inner Workings of ISIS's Intelligence Apparatus." *Perspectives on Terrorism* 11 (1). <http://www.terrorismanalysts.com/pt/index.php/pot/article/view/573>.
- Speckhard, Ph.D. Anne, and Ph.D. Ahmet S. Yayla. 2016. "Research Report: The ISIS Emni: The Inner Workings and Origins of ISIS's Intelligence Apparatus." International Center for the Study of Violent Extremism (ICSVE). http://www.academia.edu/30233937/The_ISIS_Emni_The_Inner_Workings_and_Origins_of_ISISs_Intelligence_Apparatus.
- Steinbuch, Yaron. 2016. "Brussels Bomber Brothers Plotted to Kidnap Nuclear Official." *New York Post* (blog). March 24, 2016. <http://nypost.com/2016/03/24/brussels-bomber-brothers-took-part-in-plot-to-kidnap-nuclear-official/>.
- Stollenwerk, Eric, Thomas Dörfler, and Julian Schibberges. 2016. "Taking a New Perspective: Mapping the Al Qaeda Network Through the Eyes of the UN Security Council." *Terrorism and Political Violence* 28 (5): 950–70. <https://doi.org/10.1080/09546553.2014.987341>.
- Strang, Steven J. 2014. "Network Analysis in Criminal Intelligence." In *Networks and Network Analysis for Defence and Security*, edited by Anthony J. Masys. Springer Science & Business Media.
- The Guardian. 2016. "German Intelligence Agency Disputes Reports Salah Abdeslam Had German Nuclear Files." April 14, 2016. <http://www.theguardian.com/world/2016/apr/14/paris-attacks-suspect-salah-abdeslam-had-german-nuclear-files>.
- UNODC. 2011. "Criminal Intelligence Manual for Analysts." United Nations. https://www.unodc.org/documents/organized-crime/Law-Enforcement/Criminal_Intelligence_for_Analysts.pdf.
- U.S. Department of State. 2017. "State Department Terrorist Designations of Ahmad Alkhalid and Abu Yahya Al-Iraqi." U.S. Department of State. Diplomacy in Action. August 17, 2017. <http://www.state.gov/r/pa/prs/ps/2017/08/273499.htm>.
- U.S. Joint Chiefs of Staff. 2016. "Department of Defense Dictionary of Military and Associated Terms." Office of the Joint Chiefs of Staff, JCS Pub. 1 (02). http://www.dtic.mil/doctrine/new_pubs/jp1_02.pdf.
- Vego, Milan N. 2009. *Joint Operational Warfare: Theory and Practice*. Government Printing Office.
- Wasserman, Stanley, and Katherine Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge University Press.
- Webb, Emma, and Rupert Sutton. 2016. "An Enduring Threat: Europe's Islamist Terror Networks Then and Now." Centre for the Response to Radicalisation and Terrorism and Henry Jackson Society. <https://relayto.com/the-henry-jackson-society/92ha8lN0>.
- Wellman, Barry, and S.D. Berkowitz. 1988. *Social Structures: A Network Approach*. CUP Archive.
- Yang, Song, Franziska B. Keller, and Lu Zheng. 2016. *Social Network Analysis: Methods and Examples*. SAGE Publications.

- Zhang, Mingxin. 2010. "Social Network Analysis: History, Concepts, and Research." In *Handbook of Social Network Technologies and Applications*, edited by Borko Furht, 3–21. Springer Science & Business Media.
- Zweig, Katharina A. 2016. *Network Analysis Literacy: A Practical Approach to the Analysis of Networks*. Springer Science & Business Media.

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