Network Topography, Key Players and Terrorist Networks

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Abstract
In recent years social network analysis (SNA) has enhanced our understanding of how terrorist networks organize themselves and has offered potential strategies for their disruption. To date, however, SNA research of terrorist networks has tended to focus on key actors within the network who score high in terms of centrality or whose structural location (i.e., their location within the overall network) allows them to broker information and/or resources within the network. However, while such a focus is intuitively appealing and can provide short-term satisfaction, it may be putting the cart before the horse. Before jumping to the identification of key actors, we need to first explore a network’s overall topography. Research suggests that networks that are too provincial (i.e., dense, high levels of clustering, an overabundance of strong ties) too cosmopolitan (i.e., sparse, low levels of clustering, an overabundance of weak ties), too hierarchical (i.e., centralized, low levels of variance) and/or too heterarchical (i.e., decentralized, high levels of variance) tend not to perform as well as networks that maintain a balance between these extremes. If these dynamics hold true for terrorist networks as well, then the key player approach may be appropriate in some circumstances, but may lead to deleterious results in others. More importantly, it suggests that analysts need to consider a network’s overall topography before crafting strategies for their disruption.

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1. Introduction and Background

Roberts and Everton (2009) recently argued that while social network analysis (SNA) has wide appeal as a methodology for targeting members of terrorist networks, it possesses a much wider application than is currently being used. Furthermore, they argued that strategy should drive the choice of metrics rather than the other way around. Unfortunately, just the opposite appears to be happening. The tail (i.e., the choice of metrics) is wagging the dog (strategic choices). Indeed, the most common application of SNA to the study of terrorist networks has been the key player approach, which focuses on targeting key actors within the network for elimination or capture (a.k.a. the “whack-a-mole” strategy).

While the focus on key individuals is intuitively appealing and might provide short-term results, such a focus may be misplaced and, in fact, may make tracking, disrupting and destabilizing terrorist networks more difficult. As Brafman and Beckstrom (2006) have noted, targeting key players in decentralized organizations seldom shuts them down. Instead, it only drives them to become more decentralized, making them even harder to target.

In terms of terrorist networks, such a strategy may in fact exacerbate what Sageman (2008) refers to as the “leaderless jihad,” by which he means the numerous independent and local groups that have branded themselves with the Al Qaeda name and are attempting to emulate bin Laden and his followers in conceiving and executing terrorist operations from the bottom up. Here it is suggested that analysts need to first explore a terrorist network’s overall topography (i.e., its level of density, centralization, clustering, etc.) before estimating brokerage, centrality and other types of metrics.

This is not to say analysts have completely neglected the topographical dimensions of terrorist networks. There have been exceptions. Pedahzur and Perliger (2006), for example, noted that terrorist networks with a large number of cliques appear to be more effective than those with few, and the U.S. Army’s most recent counterinsurgency manual (U.S. Army, 2007) argues that network density is positively associated with network efficiency and, as such, should guide tactics. Perhaps the best known example is Sageman’s (2004b) initial study of what he calls the Global Salafi Jihad (GSJ) in which he found that the GSJ exhibits the characteristics of a scale-free network. This discovery led him to argue that the United States should focus its efforts on taking out hubs (i.e., nodes that have many connections) rather than randomly stopping terrorists at borders. “[The latter] may stop terrorists from coming here, but will leave the network undisturbed. However... if the hubs are destroyed, the system breaks down into isolated nodes or sub-groups. The jihad will be incapable of mounting sophisticated large scale operations like the 9/11 attacks and be reduced to small attacks by singletons” (Sageman, 2004a).

While the simultaneous removal of 10-15% of a terrorist network’s hubs is easier said than done, and subsequent research has found that hubs are often quickly replaced by other, highly central and/or structurally equivalent actors (Pedahzur & Perliger, 2006; Tsvetovat & Carley, 2005), it does not change the fact that Sageman’s approach illustrates how the exploration of a network’s overall topography can inform strategic decision-making.

2. Hypothesis and Aims

In this paper I explore two interrelated but analytically distinct topographical dimensions of networks that appear to affect network performance: what I call the (1) provincial-cosmopolitan and (2) hierarchical-hierarchical dimensions. I begin by drawing on “light network” research, defined as networks that are overt and legal as opposed to “dark networks,” which are covert and illegal networks such as terrorist networks (Milward & Raab, 2006; Raab & Milward, 2003). This research suggests that networks that are too provincial (e.g., dense, high levels of clustering, an overabundance of strong ties) or too cosmopolitan (e.g., sparse, low levels of clustering, an overabundance of weak ties) tend to perform more poorly than networks that maintain a balance between the two.

Next, I turn to a series of studies that suggest that a similar dynamic is at work in terms of how hierarchical a network is: networks that are too hierarchical (e.g., centralized, high levels of variance) or too decentralized (e.g., decentralized, low levels of variance) tend to under-perform those that lie between the two extremes. I then note that if these same dynamics hold true for terrorist and other forms of dark networks, then the central actor approach may be appropriate in some circumstances but not in others. More broadly I argue that analysts need to take into account a network’s overall topography before crafting strategies or their disruption. Consequently, I conclude by suggesting what these studies imply for strategic decision-making in terms of tracking and disrupting dark networks.

3. Types of Networks

3.1 Provincial and Cosmopolitan Networks

In what is now regarded as a classic study, Granovetter (1973, 1974) discovered that when it came to finding their current job people were far more likely to have used personal contacts than other means. Moreover, of those who found their jobs through personal contacts, most were weak ties (i.e., acquaintances) rather than strong ones (i.e., close friends). This occurred because people tend to have more weak ties than strong ties (because weak ties demand less of our time), and because weak ties are more likely to form the crucial bridges that tie together densely knit clusters of people (see Figure 1). Granovetter argued that weak ties often connected otherwise disconnected groups. Thus, whatever is to be spread (e.g., information, influence, and other types of resources), it will reach a greater number of people when it passes through weak ties rather than strong ones (Granovetter, 1973, pg. 1366). Moreover, actors with few weak ties are more likely to be “confined to the provincial news and views of their close friends” (Granovetter, 1983:202).

Granovetter does not argue that strong ties are of no value. He notes that while weak ties provide individuals with access to information and resources beyond those available in their immediate social circles, strong ties have greater motivation to be sources of support in times of uncertainty (Granovetter, 1983, pg. 209). Others have noted this as well (see e.g., Krackhardt, 1992; Stark, 2007). “There is a mountain of research showing that people with strong ties are happier and even healthier because in such networks...”
members provide one another with strong emotional and material support in times of grief or trouble and someone with whom to share life’s joys and triumphs” (Stark, 2007:37). This suggests that people’s networks differ in terms of their mix of weak and strong ties. Individuals’ networks range from local or provincial ones, consisting of primarily of strong, redundant ties and very few weak ties, to worldly or cosmopolitan ones, consisting of numerous weak ties and very few strong ties (Stark, 2007:37-38). It also suggests that people’s networks should ideally consist of a mix of weak and strong ties. They should be neither too provincial nor too cosmopolitan but rather land somewhere between the two extremes.

Pescosolido and Georgianna’s (1989) study of suicide illustrates this dynamic. It found that social network density has a curvilinear (or inverted U) relationship to suicide. Individuals who are embedded in very sparse (i.e., cosmopolitan) and very dense (i.e., provincial) social networks are far more likely to commit suicide than are people who are embedded in moderately dense networks. Why? People who are embedded in sparse social networks often lack the social and emotional ties that provide them the support they need during times of crisis. They also typically lack ties to others who might otherwise prevent them from engaging in self-destructive (i.e., deviant) behavior (Finke & Stark, 2005; Granovetter, 2005). On the other hand, individuals who are embedded in very dense networks are often cut-off from people outside of their immediate social group, which increases the probability that they will lack the ties to others who could prevent them from taking the final, fatal step.

An ideal mix of weak and strong ties appears to provide benefits at the individual level as well as at the organizational level. In his study of the New York garment industry, Brian Uzzi (1996) found that a mix of weak and strong ties proved beneficial to the long-term survival of apparel firms. The firms he studied tended to divide their market interactions into two types: “market” or “arms-length” relationships (i.e., weak ties) and “special” or “close” relationships (i.e., strong ties), which Uzzi refers to as “embedded” ties. He found that while market ties were more common than embedded ones, the latter tended to be more important in situations where trust was of overriding importance, where detailed information had to be passed to others, and when certain types of joint problem-solving were on the table (Uzzi, 1996:677). According to Uzzi, embeddedness increases economic effectiveness along a number of dimensions crucial to competitiveness in the global economy: organizational learning, risk-sharing and speed-to-market. However, he also found that firms that are too embedded often suffer because they do not have access to information from distant parts of the network, which makes them vulnerable to a rapidly changing environment. This led him to argue that firms should seek to maintain a balance of embedded and market ties and found that an inverted U relationship exists between the degree of embeddedness and the probability of firm failure (Uzzi, 1996:675-676).

Interestingly, Uzzi and Spiro (2005) found that an inverted U relationship also existed in the extent to which the networks of creative teams producing Broadway musicals from 1945 to 1989 exhibited “small-worldness” and the probability that a musical would be a critical and financial success. They believe that this relationship existed because up to a point, connectivity and cohesion facilitate the flow of diverse and innovative material across the network. Moreover, connectivity and cohesion make risk-taking among the teams more likely because they are embedded in networks of trust.

As the level of Q increases, separate clusters become more interlinked and linked by persons who know each other. The processes distribute creative material among teams and help to build a cohesive social organization within teams that support risky collaboration around good ideas (Uzzi & Spiro, 2005:464).

However, as connectivity and cohesion increase, homogenization and imitation set in and returns become negative.

Increased structural connectivity reduces some of the creative distinctiveness of clusters, which can homogenize the pool of creative material. At the same time, problems of excessive cohesion can creep in. The ideas most likely to flow can be conventional rather than fresh ideas because of the common information effect and because newcomers find it harder to land “slots” on productions (Uzzi & Spiro, 2005, pg. 464).

In other words, initially connectivity and cohesion increase a network’s overall creativity by encouraging human innovation, but beyond a certain point, they begin to stifle it.

While it may be (morally) difficult to conceive of terrorist networks as varying in their ability to encourage innovative thinking and creative risk-taking, these studies should give us pause. They suggest that in order to be successful, terrorist networks can be neither too provincial nor too cosmopolitan. Of course, what constitutes the optimum balance of strong and weak ties will most likely vary depending on the environment in which it operates (e.g., the IRA can operate more openly in Ireland than Al-Qaeda can in the United States), but that still should not discourage analysts from exploring and documenting this topographical feature of dark networks.

Figure 1. Strong and weak ties (Granovetter, 1973, 1983)
3.2 Heterarchical and Hierarchical Networks

Another more well-developed body of research has explored how the degree to which an organization is hierarchically structured impacts its performance (see e.g., Nohria & Eccles, 1992; Podolny & Page, 1998; Powell, 1985, 1990; Powell & Smith-Doerr, 1994). This literature typically identifies two ideal types of organizational form: networks and hierarchies. The former are seen as decentralized, informal and/or organic, while the latter are seen as centralized, formal and/or bureaucratic (Burns & Stalker, 1961; Powell, 1990; Ronfeldt & Arquilla, 2001). While this distinction is useful (and appropriate) in some contexts (see, e.g. Arquilla & Ronfeldt, 2001; Castells, 1996; Podolny & Page, 1998; Powell & Smith-Doerr, 1994; Ronfeldt & Arquilla, 2001), it is probably better to think of these two ideal types as poles on either end of a continuum, running from highly centralized forms on one end to highly centralized forms on the other.

More importantly, at least for our purposes here, research suggests that this dimension impacts network performance much like the provincial-cosmopolitan dimension: that is, an optimal level of centralization or hierarchy exists. For example, Rodney Stark (1987, 1996), in his analysis of why some new religious movements succeed, identified centralized authority as an important factor. Nevertheless, he notes that too much centralization can be a bad thing and successful religious movements, such as the Mormon (LDS) Church, balance centralized authority structures with decentralized ones:

But it would be wrong to stress only the hierarchical nature of LDS authority and its authoritarian aspects, for the Latter-day Saints display an amazing degree of amateur participation at all levels of their formal structure. Moreover, this highly authoritarian body also displays extraordinary levels of participatory democracy—to a considerable extent the rank-and-file Saints are the church. A central aspect of this is that among the Latter-day Saints to be a priest is an unpaid, part-time role that all committed males are expected to fulfill (Stark, 2005, pg. 125).

Like the provincial-cosmopolitan dimension, the optimal level along the heterarchical-hierarchical dimension varies depending on environmental context. Decentralized structures are generally seen as better suited for solving nonroutine, complex and/or rapidly-changing problems or challenges because of their adaptability, while centralized ones are better suited for stable environments where economies of scale are of paramount importance (Granovetter, 1985; Raab & Milward, 2003). Saxenian (1994, 1996), for instance, contends that Silicon Valley emerged as the center of the high technology universe because it developed a highly-flexible industrial network — characterized by a horizontally integrated industrial system, flat corporate structures, friendly local institutions, a supportive culture and a heterarchical institutional infrastructure — that was more responsive to the volatile high technology industry than were other regional areas. And, in his reflection on the structure of terrorist organizations, David Tucker (2008) argues that while network forms of organization are useful for some tasks (e.g., mobilization), they are not useful for others (e.g., security). He also notes that the optimal form of organization depends largely on the environment in which an organization operates:

The most important issue is how well an organization’s structure is adapted to its environment, which includes what its enemies are doing, given what the organization wants to achieve and the resources available to it. No one organizational structure is always inherently superior to another. Some are better for some things, some for others. These principles apply to al Qaeda as well as the governmental network (the federal, state, and local governments) in the United States (Tucker, 2008, pg. 2).

Once again too much of a good thing can lead networks to underperform, and unless it is demonstrated otherwise, there is no reason to suspect that this same dynamic applies to terrorist networks. From their perspective they cannot be too centralized or decentralized, while from ours that is exactly how we want them to be.

4. Strategic Implications

This brief analysis of the relationship between network effectiveness and network topography suggests that analysts seeking to disrupt dark networks will want to pursue policies that push dark networks toward the tails of these two dimensions (see Figure 2).

![Figure 2. Hypothesized relationship between network topography and effectiveness](image_url)

For example, a scenario where analysts are seeking to disrupt a terrorist network that lies on the centralized side of the continuum. If, in such a scenario, they target a central actor for capture or elimination and are successful, they may cause the network to become less centralized and actually more effective. Instead, they may want to implement a misinformation campaign that breeds distrust between the network’s inner circle and its peripheral members that will hopefully lead the former to centralize decision-making, communication and strategic functions even more than they currently are. Or again, analysts may seek to disrupt a somewhat provincial terrorist network by adopting a strategy that causes it to turn in on itself (e.g., peeling off peripheral members through an amnesty campaign), thus making it more provincial and less effective.

The important point here is that the topographical features of terrorist networks should inform strategic decision-making, both
of which should come before analysts estimate centrality and other standard social network metrics.

5. Quantifying Network Topography

A number of metrics exist to quantify the topographical features of networks. In terms of the heterarchical-hierarchical dimension, degree, closeness and betweenness centralization all offer glimpses into how centralized a network is although we need to be careful how we interpret our results. In general, the larger a centralization index is, the more likely it is that a single actor is very central while the other actors are not (Wasserman & Faust, 1994, pg. 176), so they can be seen as measuring how unequal the distribution of individual actor values are. Thus, we need to interpret the various indices in terms of the types of centrality estimated.

An alternative measure recommended by Hoivik and Gleditsch (1975) and Coleman (1964) is the variance of degree centrality found in a network (Wasserman & Faust, 1994, pg. 177, 180-181). Finally, if we are working with directed data, then Krackhardt’s (1994) graph theoretical measures of hierarchy can be quite informative. To date, however, most social network analyses of terrorist networks have collected undirected data.

Network density is probably the most commonly used metric tapping into the provincial-cosmopolitan dimension. Unfortunately, network density tends to decrease as social networks get larger because the number of possible lines increases rapidly with the number of actors whereas the number of relations which each actor can maintain is generally limited. Consequently, it is of limited use as a measure. We can use it to compare networks of the same size, but that is about all. An alternative suggested by Scott (2000, pg. 75-76) and de Nooy et al (2005, pg. 63) is to calculate a network’s average degree centrality. While it is positively associated with “provincialness” of networks, it is not sensitive to network size, which allows analysts to use it to compare networks of different size.

The small world statistic developed by Uzzi and Spiro (2005) to measure the small-worldness of networks of Broadway musical teams also taps into the provincial-cosmopolitan dimension and is worth exploring in some detail here (Humphries and Gurney (2008) developed the identical statistic apparently independently of Uzzi and Spiro). As noted above, small world networks are those where actors cluster into tight-knit groups and the average path length between them is low (Watts & Strogatz, 1998). Local clustering (CC) is measured by taking the average of the proportion of an actor’s neighbors who also have ties with one another (also known as ego-network density), while average path length (APL) is calculated by taking the average of all the shortest path lengths (i.e., geodesics) between all actors in the network. These measures are then typically normalized by calculating the ratio between them and the CC and APL of a random network of the same size and density:

\[ CC_{\text{Ratio}} = \frac{CC_{\text{Actual}}}{CC_{\text{Random}}} \]  \hspace{1cm} (1)

\[ PL_{\text{Ratio}} = \frac{APL_{\text{Actual}}}{APL_{\text{Random}}} \]  \hspace{1cm} (2)

Thus, the more that a network’s \( CC_{\text{Ratio}} \) exceeds 1.0 and the closer its \( PL_{\text{Ratio}} \) approaches 1.0, the more it resembles a small world network. Uzzi & Spiro and Humphries & Gurney quantified the relationship between the \( CC_{\text{Ratio}} \) and \( PL_{\text{Ratio}} \) by calculating a ratio of ratios, so to speak (what Uzzi and Spiro called “small world Q”):

\[ Q = \frac{CC_{\text{Ratio}}}{PL_{\text{Ratio}}} \]  \hspace{1cm} (3)

Later analysis by Uzzi (2008) found that it was unnecessary to compute small world Q in order to predict the probability that a musical would be a critical and financial success. Instead, all that was needed was the \( CC_{\text{Ratio}} \). Why? Because the \( PL_{\text{Ratio}} \) almost always approximated 1.0 and recent research (Everton & Lieberman, 2009) demonstrates that Uzzi’s discovery was not an exception but the rule. In most networks the \( PL_{\text{Ratio}} \) will approximate 1.00. Moreover, because a near-perfect correlation exists between the density of an actual network and the \( CC \) of a comparable random network, there is no need to generate the latter. Small world Q can be estimated by simply calculating the ratio of a network’s CC to its density.

Unfortunately, at this point we do not know what constitutes a cosmopolitan, provincial, hierarchical and/or heterarchical terrorist network. Table 1 lists the relevant social network measures of the “trust,” “operational” and “combined” networks of the Noordin Top Terrorist network, but how these measures compare to those generated by other studies is unclear because there is not sufficient data to make such comparison.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Trust Network</th>
<th>Operational Network</th>
<th>Combined Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.081</td>
<td>0.362</td>
<td>0.378</td>
</tr>
<tr>
<td>Average Degree</td>
<td>6.557</td>
<td>28.228</td>
<td>29.443</td>
</tr>
<tr>
<td>Clustering Coefficient</td>
<td>0.356</td>
<td>0.751</td>
<td>0.763</td>
</tr>
<tr>
<td>Small World Q</td>
<td>4.238</td>
<td>2.074</td>
<td>2.019</td>
</tr>
<tr>
<td>Degree Centralization</td>
<td>21.63% (unconnected)</td>
<td>41.79%</td>
<td>40.19%</td>
</tr>
<tr>
<td>Closeness Centralization</td>
<td>42.37%</td>
<td>40.56%</td>
<td></td>
</tr>
<tr>
<td>Betweenness Centralization</td>
<td>17.88%</td>
<td>6.66%</td>
<td>5.76%</td>
</tr>
<tr>
<td>Degree Centrality Variance</td>
<td>53.487</td>
<td>222.556</td>
<td>225.639</td>
</tr>
</tbody>
</table>
### Noordin Top’s Terrorist Trust Network

The Noordin Top Terrorist Trust Network data are drawn from the International Crisis Group’s (2006) report on the terrorist networks of Noordin Mohammed Top, who is believed to be responsible for the 2003 JW Marriott Hotel and 2004 Australian Embassy bombings in Jakarta, the 2005 Bali bombing and the 2009 JW Marriott and Ritz Carlton bombings in Jakarta. The initial data were collected and coded by students as part of the “Tracking and Disrupting Dark Networks” course offered at the Naval Postgraduate School in Monterey, California, under the supervision of Dr. Nancy Roberts. Portions of the data have been updated by students in subsequent iterations of the course (through the Spring of 2009) as well as from other articles and reports by Dr. Sean Everton. One and two-mode network data were collected on a variety of relations (e.g., friendship, kinship, internal communications) and affiliations (e.g., schools, religious, businesses, training events, operations). I constructed three one-mode, multi-relational networks (trust, operational and combined) based on the relations listed below. Dichotomized versions of the networks were used to calculate metrics:

#### Trust-Network

- **Friendship:** Defined as close attachments through affection or esteem between two people. Friendship ties do not include ties based on meetings and/ or school ties.

- **Kinship:** Defined as a family connection based on marriage. It includes current marriages and past marriages due to divorces and or deaths.

- **Religious Affiliation:** Defined as association with a mosque. It does not include Islamic schools – see next category – even though such schools have mosques.

- **School Affiliation:** Educational relations are defined as schools where individuals received formal education. This includes both religious and secular institutions.

#### Operational Network

- **Internal communications:** Defined as ties based on the relaying of messages between individuals and/or groups inside the network through some sort of medium.

- **Logistical place:** Defined as key places where logistical activity – providing materials, weapons, transportation and safehouses occurred.

- **Operations:** Includes terrorists who were directly involved with the Australian Embassy bombing, the Bali Bombing, the Bali II bombing and/or the Marriott Hotel bombing, either at the scene (e.g., suicide bombers, commanders) or as a direct support to those at the scene (e.g., driver or lookout). It does not include ties formed through communications, logistics, or organizations related to the operations.

- **Terrorist Financing:** Defined as the for-profit and not-for-profit businesses and foundations that employ members of the network.

- **Terrorist Organizational Membership:** Defined as an administrative and functional system, whose primary common goal is the operational conduct of terrorist/insurgent activities, consisting of willingly affiliated claimant members. Factions and offshoots are considered separate from their parent organization.

- **Training:** Defined as participation in any specifically designated activity that teaches the knowledge, skills, and competencies of terrorism. It does not include participation in a terrorist sponsored act or mujahedeen activity in places such as Afghanistan, Bosnia, Chechnya or Iraq unless the individuals’ presence was to participate in a specifically designated training camp or base in one of these areas.
6. Conclusions

In this paper I have argued that while social network analysis has improved our understanding of how terrorist networks organize, it has generally failed to take into account a network’s overall topography before crafting strategies for their disruption. Moreover, research to date has tended to focus on identifying actors who either score high in terms of centrality or are structurally located in such a way that they are in a position to broker the transmission of resources through the network. As I have shown, however, available evidence suggests that networks that are too provincial, too cosmopolitan, too hierarchical and/or too heterarchical tend not to perform as well as networks that maintain a balance between these extremes. If these same dynamics hold true for terrorist networks as well, then identifying key actors within a network may not always be the best approach.

Clearly what are most needed in the immediate future are additional studies that explore terrorist networks in all their complexity, not only identifying their central actors but also delineating their topographical characteristics. Moreover, future research should include the development of metrics that adequately quantify the effectiveness of terrorist networks. Number and size of attacks are certainly one type of metric to consider; network resiliency is probably another (Milward & Raab, 2008). For our purposes here, however, identifying the most appropriate metric is of less concern than recognizing that only when one or more are identified will we be able to empirically confirm (or disconfirm) the hypothesized relationships theorized in this paper.

References


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