

GENEALOGY AS EVOLUTIONARY DYNAMICS

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Abstract

This paper describes the evolutionary processes of the industrial sectors using a genealogical perspective. We argue that the potency of organizational genealogies depends on two factors: (a) the entrepreneurial inclination of the founding parents, and (b) the imprinting potential of those parents, that is, their ability to imprint their values and blue-prints on their progenies as part of the process of multigenerational evolution. The study was conducted on the information technology and communication (ITC) sector in Israel. We identified six genealogies: Telrad Networks, Tadiran, ECI Telecom, RAD Data Communication, Comverse and Fibronics. Analysis of the genesis events of the founding parents' firms and the examination of their entrepreneurial activities allow us to rank the six genealogies along the entrepreneurial dimension. Analyzing the stability of the founding firms' along time and the direct intergenerational channels for diffusing their values (such as the number of serial founders or intergenerational ventures) allows us to rank the six genealogies along the second dimension – imprinting potential. We find that the firms that rank highest on the two dimensions (RAD Data Communication, Fibronics and Comverse) are higher in potency (measured by volume and pace of growth) than the three other genealogies (Telrad Networks, Tadiran and ECI Telecom).

“Although we have learned a good great deal about selection processes, we still know very little about the other side of the evolutionary process, the structures of inheritance and transmission” (Hannan and Freeman, 1989: 20-21).

How do organizations reproduce and consequently industries emerge and evolve? These questions have been discussed by theoretical frameworks underscoring organizational processes and events that profoundly influence the birth mechanism and the evolutionary trajectory of start-up firms (Aldrich and Ruef, 2006, Stinchcombe, 1965). In this paper we develop a framework of genealogical evolution of an industrial sector, exploring the ways in which new ventures are created along generational lines. We propose that the initial conditions under which the genealogy founding parents’ firm was established affect the way they spawn new ventures and are shaping both the genealogy’s evolutionary trajectory and structure. Our multi-generation analysis addresses a gap in the literature on spin-offs, which focused mainly on parents-progeny relations in the first generation as the driving mechanism of the spawning of new firms (Phillips 2000, Klepper, 2001). Furthermore, by focusing on genealogical evolution, we are able to empirically trace the specific features associated with the founding processes of new ventures in terms of their birth origin along multiple generations, which in turn influence the potency of the entire genealogy.

Studies of the spawning of firms have shown how various organizational capabilities, including knowledge, management models, and the identity of the founding firms affect the emergence, evolution, and performance of ventures founded by their ex-employees (Agarwal, Raj, Franco and Sarkar, 2004, Gompers, Lerner and Schafstien, 2005; Klepper and Sleeper, 2005). According to these studies, the inheritance process that is embedded in the dynamic interrelationships between incumbents and their progeny

can be conceived as reproduction of a 'genetic code' (Nelson 1991). This line of research has not only raised cardinal questions regarding the processes and structure of inheritance (Hannan and Freeman, 1989), but also triggered a debate regarding its implications for competition and cooperation between parents and their progeny (Franco, 2005; Klepper, 2001, Phillips, 2002, 2005). For example, theories of spinouts tend to view the nature of birth of new start-up as either 'exploiting' their parents' achievements and weaknesses or as a reaction to disagreements with parents (Klepper, 2001; Klepper and Thompson, 2006).

An important question that needs to be addressed is: How does an intra-industry spawning process of new firms evolve along time? Exploring parent-progeny relations per se does not fully reflect the evolutionary dynamics involved in the emergence of new industries as both parents and progenies are only a fraction of the entire process (Phillips, 2000; 2005) and are short of explaining the mechanism through which founding of new ventures evolves along time. In the present study we analyze the historical-genealogical evolution of the Israeli communication sector. Our analysis provides a new lens for looking at the inter-generation dynamics and sheds more light on the evolutionary dynamics of emerging industries.

A *genealogy* is defined as a record of descent or lineage of firms reflecting the type of kinship relations among them along time. Comparative analysis of genealogies enables us to learn about the differential pattern of their evolution and to uncover the mechanisms that explain why and when different genealogies would gravitate toward more or less founding of new firms. We propose that the initial conditions at the time of founding of the parent firm of a genealogy have an impact on their entrepreneurial

tendencies which in turn affect the potency of the entire genealogy in terms of its structure, growth rate and scope. In addition, the structural relations among parents and their progenies within an entire genealogy affect the parents' imprinting potential. Whereas prior research emphasized parent-progeny relations as a driving force for the founding of new firms, we examine the extent to which these relations along different genealogical lines affect the pace and scope of the founding of new organizations in an emergence industry.

In what follows, we present our perspective on the current literature on parent-progeny relations; we then describe the genealogical model, and develop our research model and hypotheses.

A genealogical perspective on parent-progeny relations

Organizational studies on parent-progeny relations can be understood in terms of three perspectives. The first perspective focuses on the *initial conditions* at founding and reviews the prospects of spin-outs by analyzing the characteristics of the spawned firms: entrants are categorized as de-novo vis-a-vis de-alio (Agarwal et al., 2004). Their pre-entry experience is examined (Carroll, Bigelow, Siedel and Tsai, 1996; Klepper and Simons, 2000), in particular when such an experience is positively associated with the introduction and persistence of new organizational forms (Simons and Roberts, in press), as well as the technological or market characteristics of the parents firms (Agarwal et al., 2004; Gompers, Lerner and Scharfstein, 2005). In studying the creation of venture capital backed startups, Gompers, Lerner and Scharfstein (2005) found that diverse initial conditions influence the prospects of entrepreneurial spawning. These includes: entrepreneurs who spun-out from public companies; entrepreneurs that spun-out from

younger firms that were themselves backed by venture capitalists and were located in one of the main ‘hubs’ of venture capital such as Silicon Valley and Route 128. Our study expands on the perspective of initial conditions in arguing that the influence of these conditions extends beyond the parent-progeny relations of the first generation.

The second perspective, the *carrying* approach, focuses on founders of spawned startups who are assumed to carry with them the ‘genes’ of the experience, skills, practices and knowledge that they acquired from the parent firms and apply them later to their newly spawned companies (e.g., Beckman, 2006; Boeker, 1997; Eisenhardt and Schoonhoven, 1996; Kraatz and Moore, 2002). For example, human resources blueprints of parent firms are important for the startup’s effectiveness and survival (e.g., Baron and Hannan, 2005). We propose that organizational blueprints and entrepreneurial tendencies are carried not only between parent and progenies, but along entire inter-generational lines. Carrying parents’ ‘genes’ has practical advantages for progenies who introduce innovations,¹ especially in areas that are related to the activities of their parent companies (Anton and Yao, 1995; Bankman and Glison, 1999). The reason is that progenies acquire the knowledge and strategy of how to exploit similar products and services from the parent company (Agarwal et al., 2004; Franco and Filson, 2000). Thus, the notion of ‘carrying’ reflects the application of practices by spin-offs that bear similarities to their parent organizations. Such practices can affect the prospects of a spin-off’s survival and

¹Aldrich (2007:80) claims that the new firm is likely to adopt a *reproducer* rather than an *innovator* strategy. The reproducer adopts routines and competencies similar to those of existing organizations and usually introduces *competence-enhancing* innovations that derive from proven practices and competencies (Anderson and Tushman 1990). An innovative stance on the other hand involves departure from existing routines and competencies and may prove unworkable ‘or outside of the selection criteria’.

success (Eckhardt and Shane, 2003; Klepper, 2001; Romanelli and Schoonhoven, 2001; Shane, 2000, 2001).

Finally, we add to the literature of the third perspective that centers on *imprinting processes* by proposing that the initial social and structural conditions during the parent firm's founding, imprint on its capabilities and core features and consequently exert an enduring effect on the entire genealogy through 'inheritance' dynamics (Klepper, 2002). As Dobrev and Gotsopoulos (2007) note: "the theory of structural imprinting argues that initial conditions exert a permanent, direct effect on subsequent developments regardless of the intermediary steps that have taken place since the start of the evolutionary process" (p. 2). Understanding the mechanism of imprinting along a genealogical line calls for examining how and why the organization's core features endure. The organization's core features imprint on its progenies (Phillips, 2002) and may eventually influence the entire genealogy. Organizational traits and blueprints, such as a strong identity, are typically resilient and less amenable to change (Hannan, Baron, Hsu and Koak, 2006). Furthermore, the influence of the founding organization is likely to be more salient when it enjoys institutional acceptance, rather than suffering from a 'legitimacy vacuum' (Dobrev and Gotsopoulos, 2007).

We contribute to the theory of imprinting by describing its association with potency in the context of genealogical evolution. We show how different types of initial conditions affect the imprinting potential and consequently the chances of birth and survival. In this vein, Burton and Beckman (2007) and Beckman and Burton (2008) used data from the Stanford Project on Emerging Companies in examining the role of firm history. They demonstrate how initial conditions affect subsequent organizational

outcomes. For instance, outcomes such as turnover rate of successors who occupy certain positions and the composition of top management teams are indications of position imprints, i.e., the legacies left by founders or by incumbents of particular functional positions. Similarly, Phillips (2005) shows how position imprint determines the persistence of gender hierarchies in newly funded law firms. Therefore, founders' blueprints tend to persist even though they may not be present in the new organization. Furthermore, Burton, Sorensen and Beckman (2002) argue for 'reputation imprinting', that is, spin-off or spawning from a prominent parent in term of position, reputation and status in the industry, influences investment decisions in the new firms as well as increase their access to opportunities and resources (Burton et al., 2002; Higgins and Gulati, 2003). Thus, well positioned and prestigious firms may imprint their spin-outs by signaling to potential investors that the spin-out founders and employees are trustworthy and technologically capable.

Organizational formation: The genealogical perspective

Our genealogical approach focuses on ancestral origin and the intergenerational evolution of diverse families consisting of either endogenously or exogenously related organizations. A firm is endogenously affiliated with a particular genealogy if it is related to it by 'birth' or by 'legal adoption'. According to this principle, we identify 6 types of memberships in a typical genealogy of firms. The first type is the founding parent, the next 3 types of membership are those related to the founding father by "birth" and the last 2 types of membership become a part of the genealogy by 'legal adoption'. In particular, these types are: (1) *The founding parent* – the origin of the whole genealogy; (2) *Independent startups* (de-novos) – firms founded by independent entrepreneurs who

'deserted' existing firms in the genealogy or were founded by serial entrepreneurs. The incumbent firm has no ownership stake in these ventures. (3) *Spin-offs* – firms that used to be a division of an incumbent firm or of one of its off-springs and became new independent entities. The incumbent firm has an ownership stakes in these spin-offs (Ito and Rose, 1994). (4) *Initiated Firms* - new ventures directly established by incumbent firms in contrast to ventures established by 'deserters'. (5) *Acquired firms* – Companies that were acquired by a company belonging to the same genealogy, that is, by an incumbent firm or one of its offspring. (6) *Mergers* – new firms created by merging two or more firms, at least one of them is already a member of the genealogy.

A firm is exogenously affiliated with a particular genealogy if it originates within a different genealogy and becomes a part of a new genealogy by 'marriage', making the joiner a co-founder, co-acquirer or partner to a merger within the designated genealogy. All firms from exogenous origins are affiliated with at least two genealogies and form the nodes that link different genealogies. Each genealogical line presents a different reproductive process and path, leading to the various characteristics of, and relations among, different genealogies.

Genealogies may vary in different ways depending on characteristics such as the number of incumbents (one or more founders or acquirers), the incumbent's origin (he/she may be from the founding firms or an ex-employee from a company in the same genealogy, they may come from an external genealogy in the same or in a different industry), and the type of industry. Genealogies can also vary according to particular types of relations between their members. Unlike a familial (human) genealogy, which is normally linear in terms of generational path, organizational genealogies vary in terms of

their affinity and linearity. Moreover, familial genealogies are usually constrained by cultural and social norms and rules that define who is entitled to perform the reproductive role, social and other roles, and the degree of affinity. Thus, a genealogy is founded by ancestors (real or mythological) and grows by their children, their grandchildren and so on (Fox, 1984).

Our perspective on genealogical evolution transcends familial societal norms of affiliation. For example, in our study cross-affinity relations (which can be also described as a kind of ‘incestuous relations’) are relatively common. They exist when spin-out are founded in a linear line by a parent teaming up with a grandchild or great grandchildren along the generational line, or by a spin-out founded by a parent and a progeny with kinship affinity (for example, kinship relationship which resemble those of ‘blood’ siblings; brother, uncles etc). Finally, multigenerational genealogies give us the opportunity not only to identify unusual inter-generational relations such as incest, but also to identify extremely potent members such as serial entrepreneurs who found new ventures in many successive generations.

We conjecture that the structure and characteristics of a genealogy and ultimately its size are affected by the nature of the particular line of heredity and affinity. The relations among founding firms and their progenies along different generations shape the genealogical growth or potency measured by the newly spawned firms. We attempt to understand the distinct influence of the founding parents on the evolutionary trajectory of the entire genealogy and eventually on their respective industrial sector. In doing so, we expand on the conceptions of the nature of heritage by analyzing the characteristics that

are transmitted through intergenerational relations (e.g., Klepper, 2001; Phillips, 2005; Beckman and Burton, 2007).

Founding Parents, Genesis Events and Entrepreneurial Tendencies

Behind every genealogical evolution lies a founding event that triggered the intergenerational progression of organizations that carry certain parental imprints in the form of strategy, routines, technology and knowledge (Klepper, 2001; Phillips, 2000, 2005). In genealogical evolution, the organization's initial ability to draw on its parent's resources and capabilities leads to isomorphism in the nature of the progeny's strategy (Klepper, 2001). Phillips (2000, 2005) claims that intergenerational closeness and homogeneity within a population of organizations carry certain traits that may predict the progeny's chance of survival:

“Populations producing a high proportion of progenies increase population homogeneity by reproducing social structure and organizational forms across generations. Not only do progeny receive routines and resources from the previous generation, but they are also rewarded with improved life chances that make them candidates to produce the next generation of organizations” (Phillips, 2005, p. 503).

Building on Phillips' ideas (2000, 2005), we examine how and to what degree founding processes lead to different evolutionary trajectories within a certain population. In particular, we focus on the Israeli information technology and communication (ITC) sector and examine its evolution along multiple generations. We argue that systematic variations within an industrial sector occur following different genesis events at the establishment of the original firm by the founding parents. Genesis events formulate

different strategic orientations and characteristics that create founding processes that ultimately lead to diverse genealogical forms with different evolutionary paths.

The most important genesis events are probably those that surround the birth of the founding parents' firm. A firm can be established as a startup that has to struggle from its very first day in a competitive environment or it can be established, say, as a spin-off or by the merging of two existing firms that can provide an initial cushion. The new firm may have to compete in an uncertain business environment or may enjoy the advantages of stable institutional markets. These different genesis events have a systematic effect on the evolving entrepreneurial character of the founding parents' and may affect their choice of the path they pursue in terms of their survival strategy. We argue that firms that were founded as startups and had to struggle in a competitive environment from their inception develop stronger entrepreneurial tendencies than firms that were founded in an institutional environment and enjoyed the advantages of secured markets.

Hypothesis 1: Founding firms that experienced different genesis events vary in their entrepreneurial tendencies; Founding firms that meet high competitive environments develop stronger entrepreneurial tendencies than firms who meet low competitive environments.

Entrepreneurial Tendencies, Imprinting Potential and Genealogical Potency

Genealogical potency, which is evidenced by the number of firms in a certain genealogy, reflects the potential of generating spin-outs from parents through multiple generations. The potency of a genealogy plays a key role in its evolution and consequently in the evolution of the entire industrial sector to which it belongs.

We argue that genealogical potency depends on two factors: (1) the entrepreneurial tendencies of the founding parents of the genealogy and (2) the

imprinting potential, namely the degree to which the organizational blueprints, shared beliefs and values set up by the founders, can be transmitted through the different generations of the genealogy.

Entrepreneurial tendency

A large part of research on entrepreneurship focused on the environmental characteristics influencing the firm's founding (Aldrich, 2000) and characteristics of entrepreneurial opportunities (Christensen, 1999). Entrepreneurship depends essentially on the decision that people make to discover, create and exploit business opportunities (Shane and Venkatamaran, 2000). Entrepreneurial tendency is a set of cognitive attributes (such as ability, intelligence, skills) and motivational attributes, of people who engage in an entrepreneurial process (Shane, Locke and Collins, 2003). Within the present context, these attributes may be either inherited or learned from past experience. We believe that entrepreneurial tendency is expressed in various business situations. Individuals, who have the set of attributes that reflect entrepreneurial tendency, interpret business situations in different ways than do others. Such people tend to establish new ventures. We conjecture that various events and environmental conditions contribute to the development and crystallization of entrepreneurial tendencies, as well as to the overall entrepreneurial atmosphere within organizations. These learned attributes may be passed on from incumbents to progenies across generations.

Furthermore, the entrepreneurial tendency of an incumbent firm toward innovation and pioneering may not only provide the necessary orientation, resources and network, but also endow the prospective start-up with legitimacy, thus increasing its chances of survival (Podolny, 1994; Stuart et al., 1999).

Hypothesis 2: The greater the entrepreneurial tendency of the founding parents, the greater the potency of a genealogy.

Imprinting potential

If desirable characteristics are to be transmitted to an entire genealogy they should be stable over time so that new firms that are ‘born’ into the genealogy can engage in imprinting and emulate their founding parents. Furthermore, when founding parents possess entrepreneurial values that are perceived as worthy of emulation by their progenies, the entire genealogy may benefit, insofar as the parents’ experience and achievements serve as ‘templates’ for the new members (DiMaggio and Powell, 1983).

Furthermore, a genealogy must have a structure that facilitates the imprinting process. For example, in genealogies with more cross-affinity relations and more serial entrepreneurs, traits may be transferred directly from early generations to later generations. In other words, the structure of a genealogy, in terms of the composition of affiliation influences the nature of imprinting.

Hypothesis 3: The greater the founding parents’ potential ability to transfer their entrepreneurial values to their progenies, the greater the potency of a genealogy.

Hypothesis 4: Imprinting potential moderates the effect of the founding parents’ entrepreneurial tendency on a genealogy’s potency. Entrepreneurial tendency have a stronger effect on potency under high (vs. Low) imprinting potential.

Method

Construction of the genealogies

The data for constructing the genealogies in the information technology and communication (ITC) sector were gathered from various sources of information on the Israeli hi-tech industry: (1) Israel Venture Capital (IVC) historical archives; (2) firms’ URL websites; (3) newspaper archives; and (4) interviews with 35 CEOs and founders of

high-tech and venture capital firms (see Appendices 1 and 2 for background information on the Israeli economy, the Israeli hi-tech industry, and in particular on the ITC sector).

Constructing the ITC genealogies involved the following steps:

(1) Compiling data: The sample includes 1032 firms (623 of them were endogenous and 409 – exogenous), which encompassed the entire companies in the communication sector (up to the end of 2005) and consequently, their respected genealogies. Collecting data on the entire sector precludes the necessity to conduct statistical tests to support our descriptive analysis on this sector.

(2) Identifying the founding parent of firms in the sector: We identified the six most senior firms in the ITC sector in Israel: Telrad Networks, Tadiran, RAD Data Communication, Comverse, ECI Telecom and Fibronics. All the thirty five interviewees mentioned above identified at least four firms, two of which, Telrad Networks and Tadiran, were considered as pioneers by the mere fact that they were the only clear-cut communication companies operating during Israel's formative years. Another firm, ECI Telecom, was founded in the 1960s and during its entire existence was considered one of the global pioneers in the field of telecommunication. Thirty-two of the thirty-five interviewees, considered RAD Data Communication, Fibronics and Comverse as founding parents because they represent three different major streams of the new Israeli ITC sector that was associated with the cascade of global telecommunication innovations of the 1980s.

(3) Describing the evolution of each genealogy: We traced the evolution of each genealogy by employing two approaches – top-down and bottom-up, as well as a cross-section between them. In the bottom-up approach we organized the individual firms

according to the founding date and reviewed the employment history of the founders. We traced the affiliation of the founders of spinouts and delineated the founders' intergenerational relations from the most recent founder back to the founding parent of the entire genealogy. The top-down approach followed similar lines. We started from the founding parent of the genealogy and outlined the generational succession up to the most recent founders. In cases of missing data we interviewed the founders themselves, or searched other sources such as newspapers and sources on the Internet.

(4) Mapping the genealogies: Using the Pajek software we drew network maps of each genealogy (see Figures 1a-6b). These maps illustrate the interrelationship among the members of each genealogy and between genealogies, enabling us to understand the nature of the intergenerational relations in each genealogy.

[Insert Figures 1a through 6b about here]

The firms that are included in each genealogy are divided into two groups: endogenous and exogenous. Firms considered endogenously affiliated with a particular genealogy are the founding parents' firm, de-novos, and those created by mergers, acquisitions and spin-offs. The distribution of firms in each genealogy according to type of birth is presented in Table 1a. The distribution of firms of each of the genealogies according to genealogical parenthood affiliation (endogenous and exogenous) is presented in Table 1b.

[Insert Table 1a and 1b about here]

History and major genesis events of the six founding parents' firms

Table 2 summarizes the major genesis events of the six founding parents' firms (see Appendix 2 for a detailed description of the historical evolution of the founding parents' firms).

[Insert Table 2 about here]

As can be seen from Table 2, the founding parents had different strategies with regard to resources – knowledge creation vs. acquisition, as well as target markets – local and institutional vs. competitive and international. RAD Data Communication, Fibronics and Comverse were founded as startups that from the very beginning based their strategy on knowledge creation, while Tadiran and Telrad Networks focused initially on knowledge acquisition (see Table 2 and in the Appendix). RAD Data Communication, Fibronics and Comverse began as young startups led by founders who were oriented toward both business and R&D and operated in competitive environments. Furthermore, their creative founding teams had been nurtured in the most creative and innovative scientific units of the Israeli Defense Forces.

RAD Data Communication had the advantage of both a technological entrepreneur and a business oriented entrepreneur that led its management to establish technologically diversified areas within the ITC sector. They were not only the owners of the technological ideas but the main investors. In contrast, Comverse channeled its efforts toward development and business control of a particular interrelated technological niche – voicemail and surveillance. To this end, it invested in R&D and also acquired a large number of firms to gain competitive knowledge and to reduce competition. RAD Data Communication avoided becoming a public company, because its founders preferred to retain absolute control over their first founded firm. In contrast, Fibronics and Comverse

went public on the NASDAQ a few years after founding. These two firms differ from RAD in their growth strategy. Whereas RAD Data Communication expanded by founding new innovative technological firms, Comverse expanded mainly through M&As. Thus, RAD Data Communication consistently exhibited an entrepreneurial strategy, while Comverse opted to control its niche by developing new technologies and reducing competition in their domain.

In contrast to RAD Data Communication and Comverse, Fibronics, which was a world leader in developing fiber optics technology, did not initiate and did not acquire even a single firm during its 17 years of existence. The event that triggered the rapid growth of this genealogy was an internal conflict that led the exit of the firm's creative and influential CEO who left in 1984 to found Adacom, which became later Fibronics's main competitor. We trace 23 companies which were founded by Fibronics deserters (almost 10% of the highest number of Fibronics' employees at its peak) between 1984 and the end of 2005.

In contrast to RAD Data Communication, Fibronics and Comverse, Tadiran and Telrad Networks represent firms that operated in a centralized and protected-institutionalized communication sector of the Israeli market until the 1980s. Through Koor, their holding company which was horizontally integrated and politically well connected, both Tadiran and Telrad Networks were practically free from external competition and did not have to invest in R&D beyond the direct needs of their institutional clients. They only had to cope with the uncertainties of competitive markets during the 1980s', when the Israeli economy underwent a process of liberalization and

privatization. However, Tadiran, which was heavily involved in military projects, had to turn around and invest resources in innovation and knowledge creation.

Thus, the genesis events of RAD Data Communication, Fibronics and Comverse have most likely led to the development of a highly entrepreneurial orientation. On the other hand, the genesis events of Tadiran and Telrad Networks may have led to a rather low entrepreneurial inclination.

ECI Telecom can be placed in the middle between Telrad Networks and Tadiran and RAD Data Communication, Fibronics and Comverse. ECI Telecom was not founded as a startup but as a merger between two small companies. Taking its first steps as a unified company, ECI Telecom focused mainly on the defense market. However, ten years later, in the 1970s, it changed its strategy and made extensive investments in innovative R&D and carved its way into international competitive markets.

The entrepreneurial tendency dimension

Entrepreneurial activity can serve as a proxy for the entrepreneurial tendency of the firm. We measure the entrepreneurial tendency of the founding parent companies by the number of ventures they established. This variable demonstrates the ability of the founding parents to push for additional creation and growth among its affiliates.

Table 1a shows the expansion strategy of each of the founding firms. In accordance with our first hypothesis, RAD Data Communication is a unique example of extensive entrepreneurial activities, having established 26 new ventures. Comverse founded only 5 new ventures but demonstrated its entrepreneurial tendencies through extensive acquisitions activities. Finally, it should be noted that although Fibronics was not involved in either founding new ventures or in acquisition of other firms, the

founding parent of Fibronics founded 6 new ventures before and 10 ventures after founding Fibronics.

In sum, the founders of RAD Data Communication, Comverse and Fibronics were engaged in creating new companies, and set an excellent entrepreneurial example for the next generations. This was not the case with Tadiran, Telrad Networks and ECI Telecom.

The imprinting potential dimension

The transfer of entrepreneurial values from the founding parents to their successors and from generation to generation within a genealogy is facilitated by direct relations between the founding parent and their progenies. These provide channels for the transmission of values and blueprints. As demonstrated in Table 3, all founding firms, whether they were established in the 1950s or 1980s, continue to spawn progenies (de-novos) across generations. In other words, firms of the first generation continued to spawn new ventures in parallel to firms from the sixth, seventh or eighth generations. However, only RAD Data Communication, Fibronics and Comverse spawned de-novos in all the generations of their genealogies.

Five genealogies engaged in cross-generational founding, that is, they found new ventures with entrepreneurs from companies that represent different generations within the genealogy. Such co-founding can be described as cross-affinity relations that allow the founders from early generations the opportunity to transfer values and blueprints directly to firms in newer generations. We counted a total of 24 cross affinity relations in the three genealogies of RAD Data Communication, Comverse and Fibronics, but only 9 in the genealogies of Telrad Networks, Tadiran and ECI Telecom (see Table 3).

[Insert Table 3 about here]

Another channel that allows quicker transmission of blueprints is the one opened by serial entrepreneurs. Seventy one entrepreneurs in the genealogy of RAD Data Communication were involved in founding more than one new venture, 37 in Comverse and 39 in Fibronics. In contrast, only 13 serial founders were found in Telrad Networks, 27 were found in Tadiran, and 28 in ECI Telecom. The potential influence of the founding parents' values on their genealogies through this channel are stronger in RAD Data Communication, Fibronics and Comverse than the other three – Telrad Networks, Tadiran and ECI Telecom.

The dependent variables: Founding parents' potency and genealogy potency

To measure genealogy potency we constructed three different variables: volume, pace of growth and openness.

Volume: This variable represents the genealogy size or in more specific terms – the number of spawned startups founded by independent entrepreneurs who left their incumbent organizations (de-novos). This variable does not include spin-offs (founded by incumbent firms) or other firms in which the founding firms have business interests. As de-novo firms do not have any business relations with the founding firm or their own incumbents, they best reflect the indirect impact of the founding parents on genealogical potency across generations. Our data allows us to count the number of de-novos in each genealogy from the day of founding the parents' firm until December 31st, 2005.

Pace of growth: Genealogical potency reflects also the speed of genealogical evolution in terms of the number of new generations and the number of spawned startups in each generation. It is measured by (1) the number of years per generation (life

duration/number of generations), and (2) the pace of growth in terms of the number of new independent ventures (de-novos) founded per year.

Openness: Firms can be related to a particular genealogy endogenously or exogenously. As mentioned earlier, firm is exogenously affiliated with a particular genealogy if its origin is in a different genealogy. The number of exogenous co-founders, co-acquirers and parties to mergers reflects the openness of a genealogy to joint operations with other genealogies .

Findings

Genealogy potency

Tables 4a and 4b display the potency measures for the six genealogies.

[Insert Table 4a about here]

Volume: The six genealogies differ on all three volume measures. Even though RAD Data Communication, Fibronics and Comverse began as small startups in the beginning of the 1980s, they spawned more de-novos than Tadiran, Telrad Networks and ECI Telecom, which were founded in the beginning of the 1950s and 1960s by relatively powerful holding companies. These findings support hypotheses 2-4 because RAD Data Communication, Fibronics and Comverse were ranked highest on both entrepreneurial tendencies and imprinting potential.

Pace of growth: The pace of growth of the RAD Data Communication, Fibronics and Comverse genealogies was the fastest. As expected, the genealogies of RAD Data Communication, Fibronics and Comverse are ranked first, second and third according to spawning rate per year, while Tadiran, ECI Telecom and Telrad Networks follow in fourth, fifth and sixth places, respectively. As Table 4a shows, the genealogies of RAD

Data Communication, with 3.91 new ventures per year, Fibronics with 3.75 ventures per year and Comverse, with 3.5 new ventures per year, are followed by, Tadiran (2.51), ECI Telecom (1.56), and Telrad Networks (0.44). Fibronics, RAD Data Communication and Comverse also lead the pack in intensity of founding pace, with the shortest average number of years per generation. The average number of years per generation for Comverse (2.75) Fibronics (2.8), and RAD Data Communication (3.28) shows a relatively fast generational pace, while the others, Tadiran (6.14) ECI Telecom (8.8), and Telrad Networks (10.8) are slower in pace. The findings pertaining to both measures support hypotheses 2-4.

Potency trend - genealogical resilience: Table 4b provides evidence on the resilience of the Israeli ITC sector in general and the genealogies with an entrepreneurial bent in particular. There are differences between the frequency values within each of the genealogies. As demonstrated in Table 4b, the turning point in the evolution of the Israeli ITC sector was in 1991. Between 1991 and 1996, all the genealogies spawned more progeny than in any prior five-year window.

[Insert Table 4b about here]

The difference in potency trends among RAD Data Communication, Fibronics and Comverse and ECI Telecom, Telrad Networks and Tadiran is nicely expressed in the period following the hi-tech bubble crisis (2001). There is a clear difference between the potency trend of RAD Data Communication, Fibronics and Comverse which scored higher on the entrepreneurial tendency and imprinting potential dimensions, and the genealogies of ECI Telecom, Tadiran and Telrad Networks, which scored relatively low on these dimensions. Whereas the potency growth of Tadiran, Telrad Networks and ECI

Telecom, slows during the 2001-2005 period; up from a total of 76 in 1996-2000 for the three genealogies to 85), RAD Data Communication, Fibronics and Comverse show accelerated growth during the same period (from 85 to 137). Taking into account the size (number of employees) of the six founding companies in 1990 (Tadiran - 14,000; Telrad – 2500; ECI – 1500; RAD Data Communication – 250; Fibronics – 400; Comverse - 175), the latter three firms appear to be according to our expectations, much more potent during the 2000-20005 period.

Openness: Another way of evaluating the expansion of a genealogy is by the number of its exogenously related firms, that is, firms co-founded or co-acquired by firms belonging to the genealogy. Table 1b displays the frequencies of external affiliates in each of the six genealogies. The relative number of external affiliates of RAD Data Communication, Fibronics and Comverse is higher than the relative number of external affiliates of Telrad Networks, Tadiran and ECI Telecom. Furthermore, since the six genealogies differ in their age, it makes more sense to observe the number of external affiliates per year. When we take into account the age and size of the genealogy's founding parents firm, the findings support hypotheses 2, 3 and 4 even stronger (Comverse in the first place (4.36), RAD is in second place (3.95) and Fibronics in the third place (1.82). Tadiran follows in the fourth place (1.67), ECI Telecom in the fifth place (1.63) and Telrad Networks (0.44) in the sixth place).

Discussion and Conclusions

This paper traced the evolution of the Israeli ITC sector with a focus on how founding parents' characteristics create opportunities for spawning of new firms. We argued that genesis events and the structure and characteristics of the environment at the

time of founding have an impact on the entrepreneurial tendencies of the founding parents and ultimately on their descendants. Our analysis demonstrates path dependence; organizational traits are passed on from one generation to the next and preserve the propensity of the founding parents to spawn new ventures.

Our conceptualization of the genealogical forms rests on the idea that imprinting potential and entrepreneurial tendency of a genealogy are the source of its diverse evolutionary path. In this vein, we showed that RAD Data Communication, Comverse and Fibronics exhibited relatively high potency which is manifested by diverse birth forms, including founding by serial entrepreneurs and cross-affinity relations. The genealogies also exhibit different potency rate along years. Lower potency rate in certain periods (such as those of Telrad Networks, Tadiran, ECI Telecom, since 2000) may well be attributed to the exhaustion of their imprinting potential. Furthermore, low or inconsistent potency may also stem from limited birth forms, which provides evidence for limited entrepreneurial tendency.

The data demonstrate that certain genesis events and conditions appear to induce firms in later generations to establish more new firms than others. Genealogies that were rated as having strong entrepreneurial tendency and high imprinting potential such as RAD Data Communication, Fibronics and Comverse, score high on all measures of potency and spawned more new firms than the other three (i.e., ECI Telecom, Telrad Networks and Tadiran). The former firms were founded as startups in the late 1970s and the beginning of the 1980s and exhibited entrepreneurial spirit, invested in knowledge creation and operated in competitive markets from the very beginning. They spawned more companies than the other three founding firms, which were founded 20 years earlier

by relatively strong holding companies and enjoyed the privilege of institutional markets. Furthermore, in spite of the tendency of firms to decrease activity during downturns in the market, RAD Data Communication, Fibronics and Comverse “responded” to the 2000’s hi-tech crisis (followed the ‘bubble burst’ of the Internet) by intensifying their entrepreneurial activities, and increased the number of de-novos they spawned.

Interestingly, as our findings illustrate, the continued existence of founding parent firms was not always related to the potency of a genealogy. For example, RAD Data Communication, Comverse, ECI Telecom and Telrad Networks all of whom are still in existence, differed on all the potency measures. Furthermore, Tadiran’s genealogy whose founding firm ceased to exist in its original form in the early 1990s was relatively potent through 2005. Finally, Fibronics that existed for only 17 years created the most potent genealogy. Thus, a founding firm that has a relatively short time to operate as a model for newer generations can still create a highly potent genealogy. Once their values, characteristics and blueprints have been transferred, their actual existence is not necessary for potency growth. Yet, the existence of active founders who create relations with off-springs as in the case of RAD is likely to increase potency.

Evolutionary economics emphasizes the impact of technology and various types of organizational routines on organizational development, focusing on the internal influence of organizational traits and mechanisms (e.g., modus operandi, organizational structure, work procedures) on a firm’s evolutionary path (Nelson and Winter, 1982). Firm history and initial conditions also affect the prospects of survival and growth of a genealogy. Organizational theorists conceive of a genealogy as representing an evolutionary path that is influenced by both internal dynamics and interrelationship

among firms within a genealogy (Phillips, 2000). External factors such as the institutional environment and contextual variables also have a determining impact (Baum and Rao, 2004). Thus, genealogical evolution is affected not only by the nature of the environment but also by the capacity for internal imprinting values such as entrepreneurial inclination across generations.

Our study expands on the notions of Klepper (2001) and Phillips (2005) concerning heritage relations and elaborates on the ideas of transmission of traits, values and blueprints (see also Burton et al., 2002; Burton and Beckman, 2007; Simmons and Roberts, in press). The focus on multigenerational evolution offers an opportunity to develop a theoretical framework that is principally concerned with the ability to detect the tenacity of founding along historical periods. Thus, a genealogy that transmits norms and values conducive to entrepreneurial initiatives tends to retain its tenacity along generational lines (see Aldrich and Zimmer, 1986).

Overall, we contributed to the development of the genealogical analysis of organizations in several ways. First, our data imply that entrepreneurial routines and values are likely to remain stable along generational lines. This may contradict common intuition, which conceives of a steady decay of influence of the founding parent of a genealogy over its progenies in time.

Second, we showed that industrial evolution is heterogeneous. Research has shown that populations of organizations emerge, grow and decline as a consequence of concentration (Hannan and Carroll, 1992), entry rate (Winter, 1984; Hannan and Freeman, 1989), and competition over resources (Baum and Singh, 1994). Our study

showed that certain genealogies exhibit steady rates of potency even under extreme market volatility, such as in the Internet bubble burst of 2000.

A third contribution to organizational genealogy studies is our endeavor to understand the structure of inheritance and transmission of values and norms along generational lines (Hannan and Freeman, 1989). Earlier research documented the development of genealogies by tracing a single line of descendants and identifying its patterns of affinity (e.g., Phillips, 2000, 2005). We revealed the complexity of intergenerational relations and identified more complex patterns of affinity by pointing at the existence of different genealogical structures. One such distinct entrepreneurial genealogy was apparent in RAD Data Communication, with its extensive cross-affinity relations that transcend generations. The founding parents of RAD Data Communication joined progenies from the fifth, sixth, and seventh generations to spin out new organizations. Thus, as our findings show, cross-affinity genealogies were the most potent in terms of number of off-springs. Furthermore, cross-affinity relations facilitated the transmission of the founding parents' values to (then) future generation firms and influenced the genealogical potency.

The fourth contribution we make is in extending the genealogical approach and providing a stronger link between genealogical structure and the historical context. Studies of the emergence of the Israeli ITC sector focus on the opportunity structures, capabilities and geographic clusters (Avnimelech and Teubal, 2004; Breznitz, 2004; de Fontenay and Carmel, 2001, 2004). Genealogy research enables us to draw attention to the dynamics of the evolution of the sector while relating to the effects of structures and social relations. We suggest that genealogical evolution is the key mechanism for

understanding the rate and extent of founding new organizations. Furthermore, as we showed, the social structure of certain genealogies facilitates founding, growth and survival of progeny by enabling social ties, parental imprinting of values and channeling of knowledge.

The current research informs us on the processes affecting genealogical evolution along intergenerational lines. We presented the dynamics associated with founding new firms through processes of imprinting entrepreneurial values. Each genealogy has specific structural characteristics that reflect its potency. Our research suggests that parent-progeny interdependence is enduring and consistent with organizational phenomenon: genealogies are formed and their nature is determined through the imprinting of specific traits of ancestors. As spin-outs evolve from the founding parents, their 'genetic load' is legible to the following generations. Our findings about the influence of the imprinting process suggest that certain characteristics of the parents have a direct bearing on the potency of the entire genealogy. This has important implications for how we understand the process of the emergence of a new industry in general and the interdependence between those ventures, which are part of the same genealogy in particular. From the progeny perspective, being a part of a potent genealogy and inheriting certain values may well hold the promise of survival.

Genealogy as a demonstration of organizational evolution through path dependence, which influences the potential of spawning new firms, received relatively little attention in the literature. Scholars rarely studied genealogies beyond parents-progeny relations (see e.g., Phillips 2000, 2005, and Miner et al, 2007). Our paper contributes to organizational genealogy theory by filling the gap regarding the nature of

genealogical potency as influencing growth of an entire industrial sector. The six genealogies exhibited four models of growth. RAD Data Communication expanded by deliberate initiation of new ventures, Comverse expanded by intensive mergers and acquisitions; ECI expanded by establishing spinoffs, Tadiran and Telrad exploited their relations with the institutional market to survive and Fibronics, which showed a remarkable potency, demonstrated that the legacy of a founding firm can last a long time even after the founding firm cease to exist. Thus our research suggests that genealogical evolution depends on founders' strategic and entrepreneurial tendencies once the founding firm was perceived as a model, even without founders' direct influence on potency outcome.

Finally, our study has several limitations. First, although we examined 852 firms of an entire industrial sector, it covers only six genealogies which differ in size and age. Second, we built our framework on the assumption that routines and values are transferred along the genealogical lines but we did not measure what was transferred. In studying the emergence of new organizational forms over a long period of time such material may not be easy to obtain. Future research should focus on contexts where more genealogies can be identified and attempt to examine and measure the content that is transmitted along genealogical lines.

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Table 1a: Distribution of firms according to genealogy and type of birth***

		Type of birth				
		de-novo	Initiated*	Acquired**	Merger	Spin-off
Telrad	Frequency	24	3 (0)	2 (2)	2	1
	% within genealogy	70.58%	8.82%	11.76%	5.88%	2.94%
Tadiran	Frequency	104	0 (1)	6 (5)	0	8
	% within genealogy	83.87%	0%	8.87%	0%	6.45%
RAD	Frequency	93	26 (1)	2 (3)	2	2
	% within genealogy	72.09%	20.93%	1.5%	1.44%	1.5%
Comverse	Frequency	77	5 (3)	15 (4)	2	15
	% within genealogy	68.8%	4.5%	13.4%	1.8%	13.4%
ECI	Frequency	62	0 (0)	3 (0)	1	5
	% within genealogy	86.1%	0%	6.9%	1.4%	4.2%
Fibronics	Frequency	104	0 (6)	0 (5)	0	0 (1)
	% within genealogy	99.1%	0%	0%	0%	4.4%

* Firms initiated by the founding firm. In parentheses – firms initiated by other members of the genealogy.

** Firms acquired by the founding firm. In parentheses – firms acquired by other members of the genealogy.

*** The six founding firms are not included in the Table.

Table 1b: Distribution of firms in each genealogy according to type of genealogical parenthood

		Type of genealogical parenthood		
		Endogenous	Exogenous	Total
Telrad	Frequency	35	24	59
	% within genealogy	59.3%	40.7%	100%
Tadiran	Frequency	129	72	201
	% within genealogy	64.2%	35.8%	100%
Rad	Frequency	132	91	223
	% within genealogy	59.2%	40.8%	100%
Comverse	Frequency	115	96	211
	% within genealogy	54.5%	45.5%	100%
ECI	Frequency	87	72	159
	% within genealogy	54.7%	45.3%	100%
Fibronics	Frequency	125	54	179
	% within genealogy	69.8%	39.6%	100%

Table 2: Major genesis events of the founding firms of the six genealogies

	Telrad	Tadiran	RAD	Comverse	ECI	Fibronics
Birth	Private company owned by a holding corporation controlled by the unions	Merger of two private companies owned by a holding corporation controlled by the unions	Startup: private company	Startup: private company	Merger of two private companies. Acquired by a state-controlled holding corporation in 1973	Startup: private company
Founders	Engineer (founder of the first electric power plant in Israel)	Professional manager (former director General of the Ministry of Defense)	Two engineers (a former chief scientist of a military intelligence unit and the other – owner of an electronic equipment agency)	An engineer and a professional manager (one a scientist and the other a finance expert)	Engineer (former American colonel, new immigrant)	Two founders: 1. Israeli engineer, serial entrepreneur 2. American businessman
Founding year	1951	1962	1981	1982	1961	1977
First IPO	---	---	---	1992	1990	1983
First Market	Institutional	Institutional	Competitive	Competitive	Institutional	Competitive
Major crises	Early nineties Hi-Tech Bubble Burst	Late 1980s Hi-Tech Bubble Burst	Hi-Tech Bubble Burst	Mid-1980s Hi-Tech Bubble Burst	Hi-Tech Bubble Burst	3 years after birth 1987 – resignation of the CEO 1991-1994-FDDI crisis
R&D policy	First stages: knowledge acquisition: 2 contracts Later stages: knowledge creation – investment in R&D	First stages: knowledge acquisition: 4 contracts Later stages: knowledge creation – investment in R&D	Knowledge creation: investment in R&D	Knowledge creation: investment in R&D	Knowledge creation: investment in R&D	Knowledge creation: investment in R&D

Table 3: Imprinting potential indicators of the six founding firms

	Telrad	Tadiran	RAD	Comverse	ECI	Fibronics
N of controlling owners	2	1	1	1	2	3
Years of founding firm's survival	55 1951-2005	27 1962-1988	24 1982-2005	23 1983-2005	45 1961-2005	18 1977-1994
Years of existence relative to genealogy age	100%	60.12%	100%	100%	100%	47.36%
Years of founder's control over the founding company	Few years	Few years	From the first day till 2005	From the first day till 2005	Few years	From the first day till 1994
N of incest relations cases	0	4	13	5	5	6
N of serial entrepreneurs (founded 2 or more ventures)	13	28	71	37	27	39

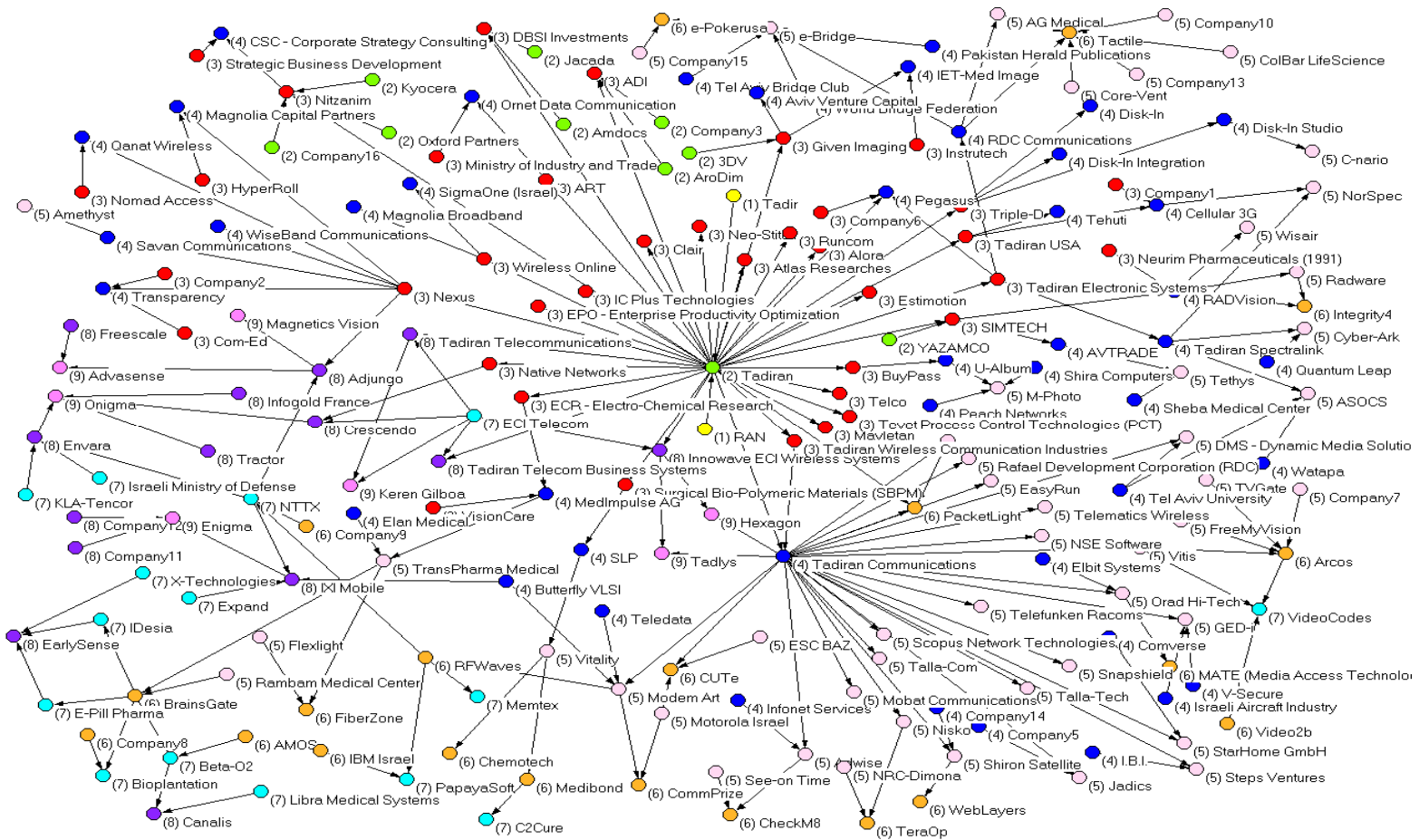
Table 4a: Potency measures of the six genealogies: Volume and pace of growth

	Telrad	Tadiran	RAD	Comverse	ECI	Fibronics
<i>Volume</i>						
Number of de-novos	24	106	93	77	62	104
<i>Pace of Growth</i>						
Number of generations	6	7	7	7	5	10
Number of years per generation	54/6=10.8	43/7=6.14	23/7=3.28	22/7=2.75	44/5=8.8	28/10=2.8
Number of de-novos per year	24/54=0.44	106/43=2.51	93/23=4.04	77/22=3.5	62/44=1.56	111/28=3.75

Table 4b: Potency of the six genealogies: Number of de-novos across years

	1932- 1980	1981- 1985	1986- 1990	1991- 1995	1996- 2000	2001- 2005
Telrad	0	0	0	3	5	13
Tadiran	1	0	3	14	45	40
RAD	0	0	1	4	38	40
Comverse	0	1	4	4	25	40
ECI	0	0	0	1	26	32
Fibronics	0	1	4	13	32	57

Figure 1a: Genealogy of Tadiran *



- Numbers in parentheses indicate generations
- Tadir and Ran, the source companies of Tadiran are included in the map

Figure 1b: Genealogy of Tadiran by generation (no labels)

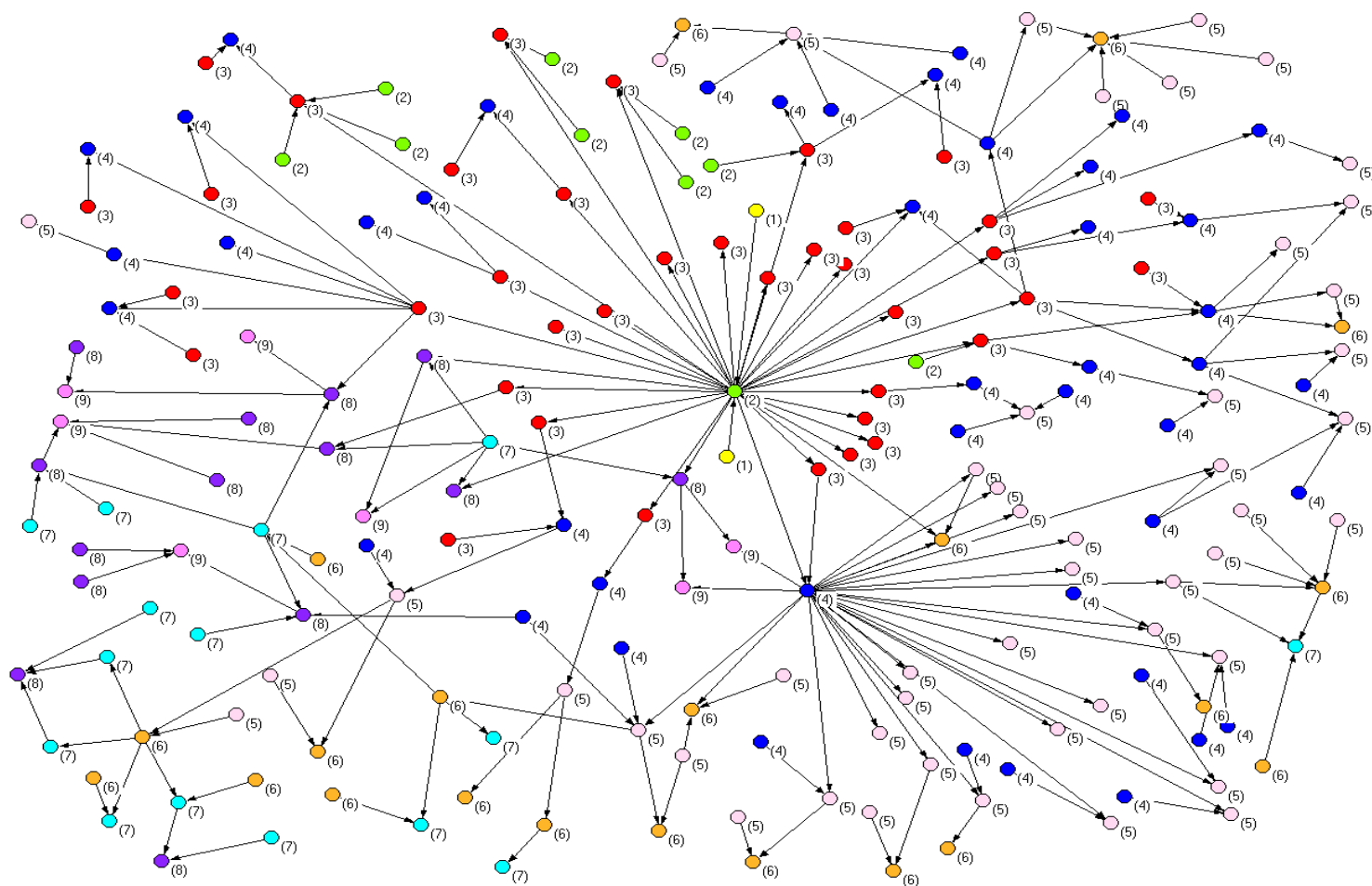


Figure 2b: Genealogy of Telrad Networks by generation (no labels)

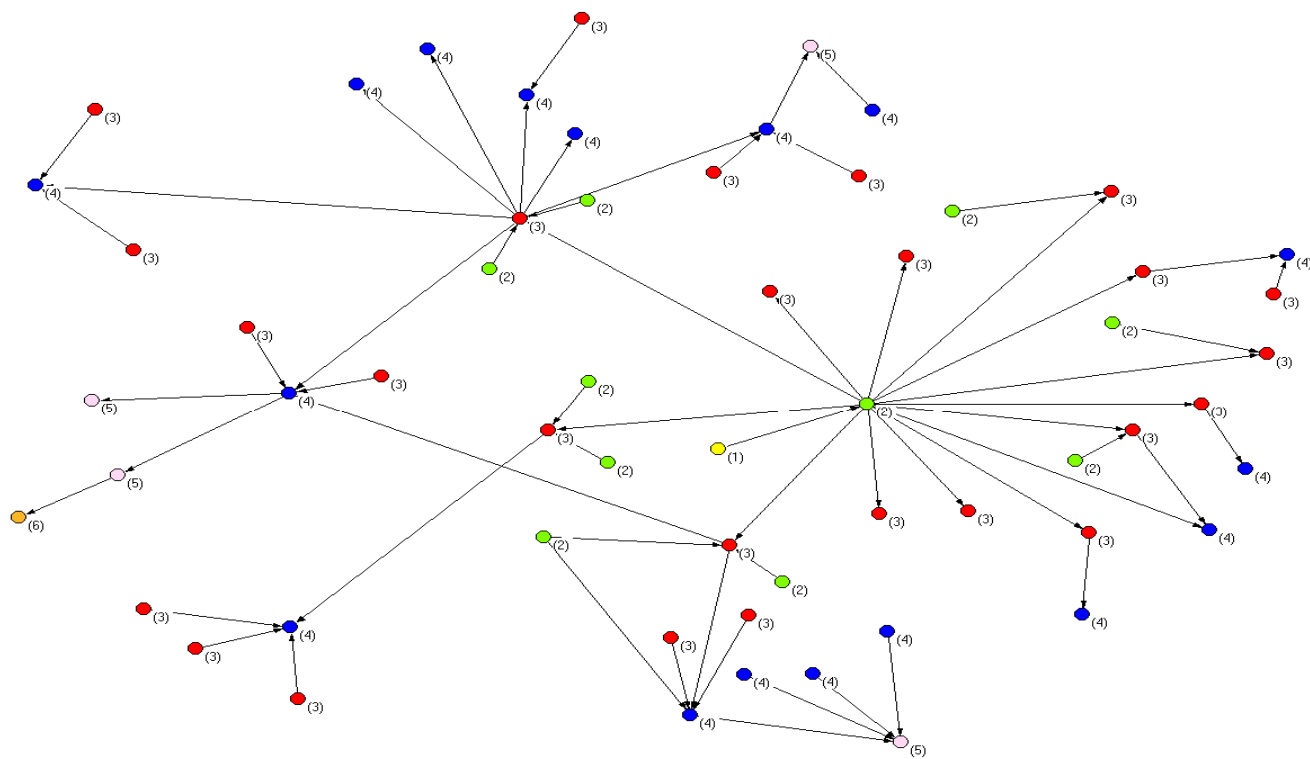


Figure 3a: Genealogy of RAD Data Communication

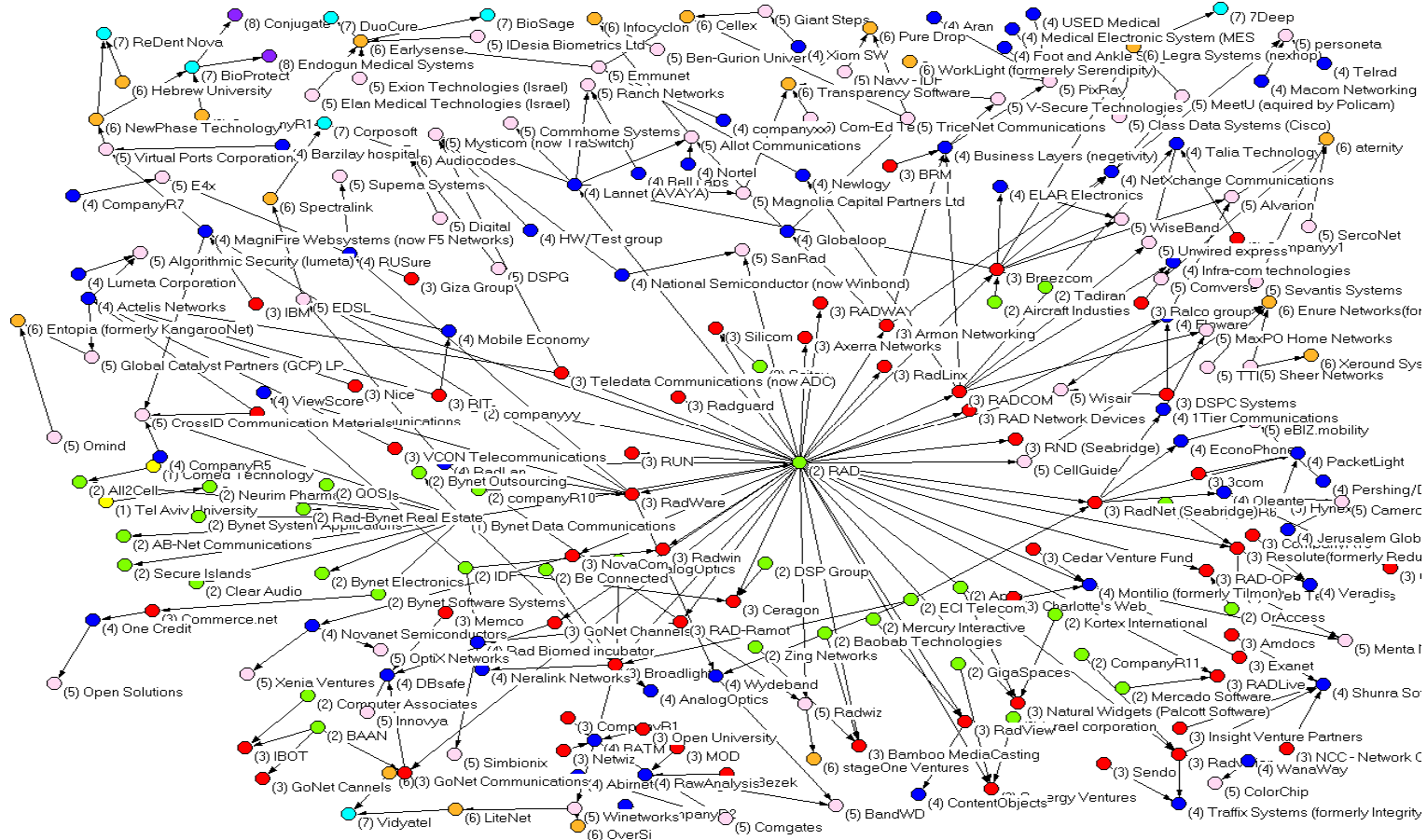


Figure 3a: Genealogy of RAD Data Communication by generation (no labels)

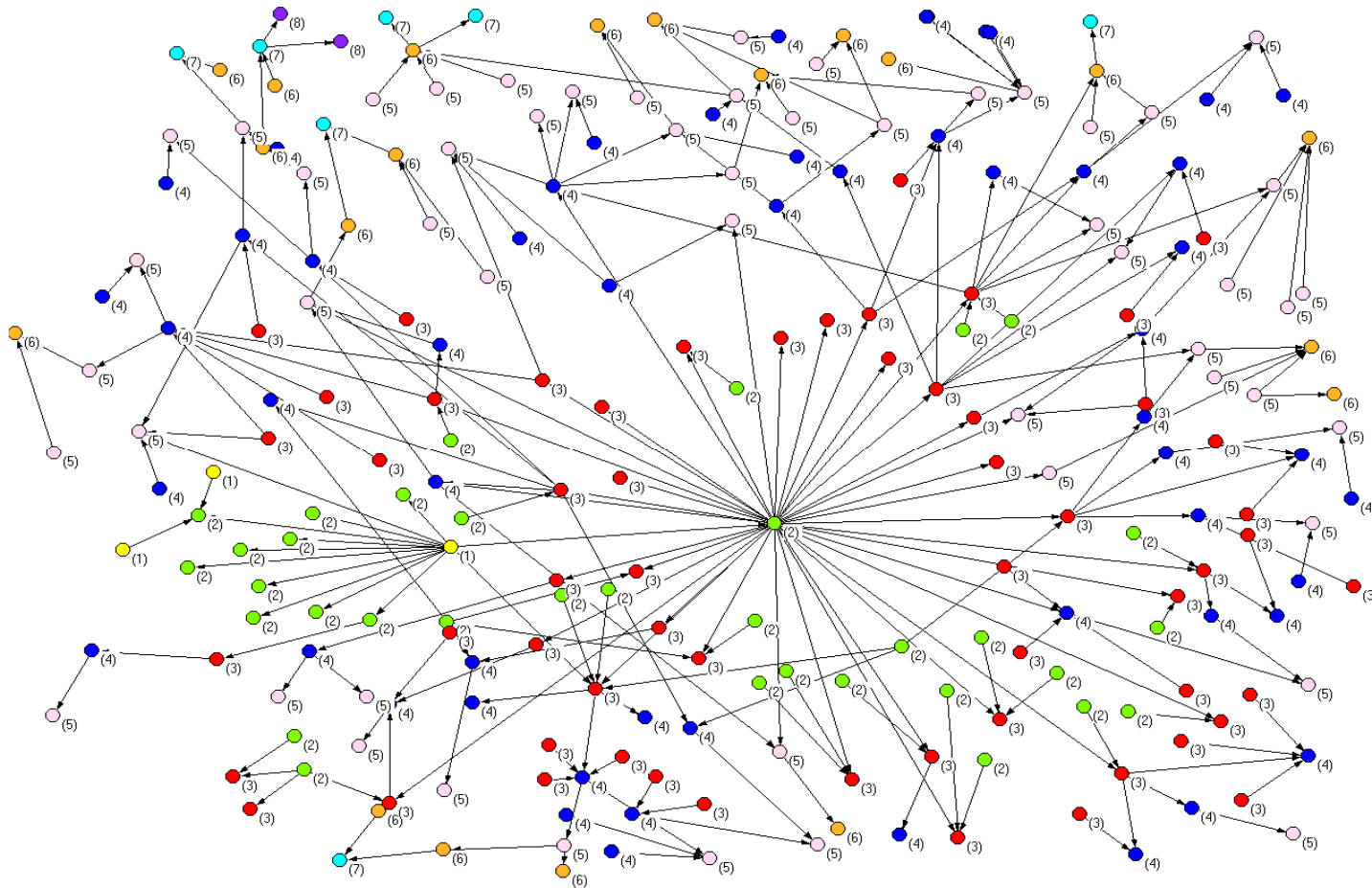


Figure 4b: Genealogy of Comverse by generation (no labels)

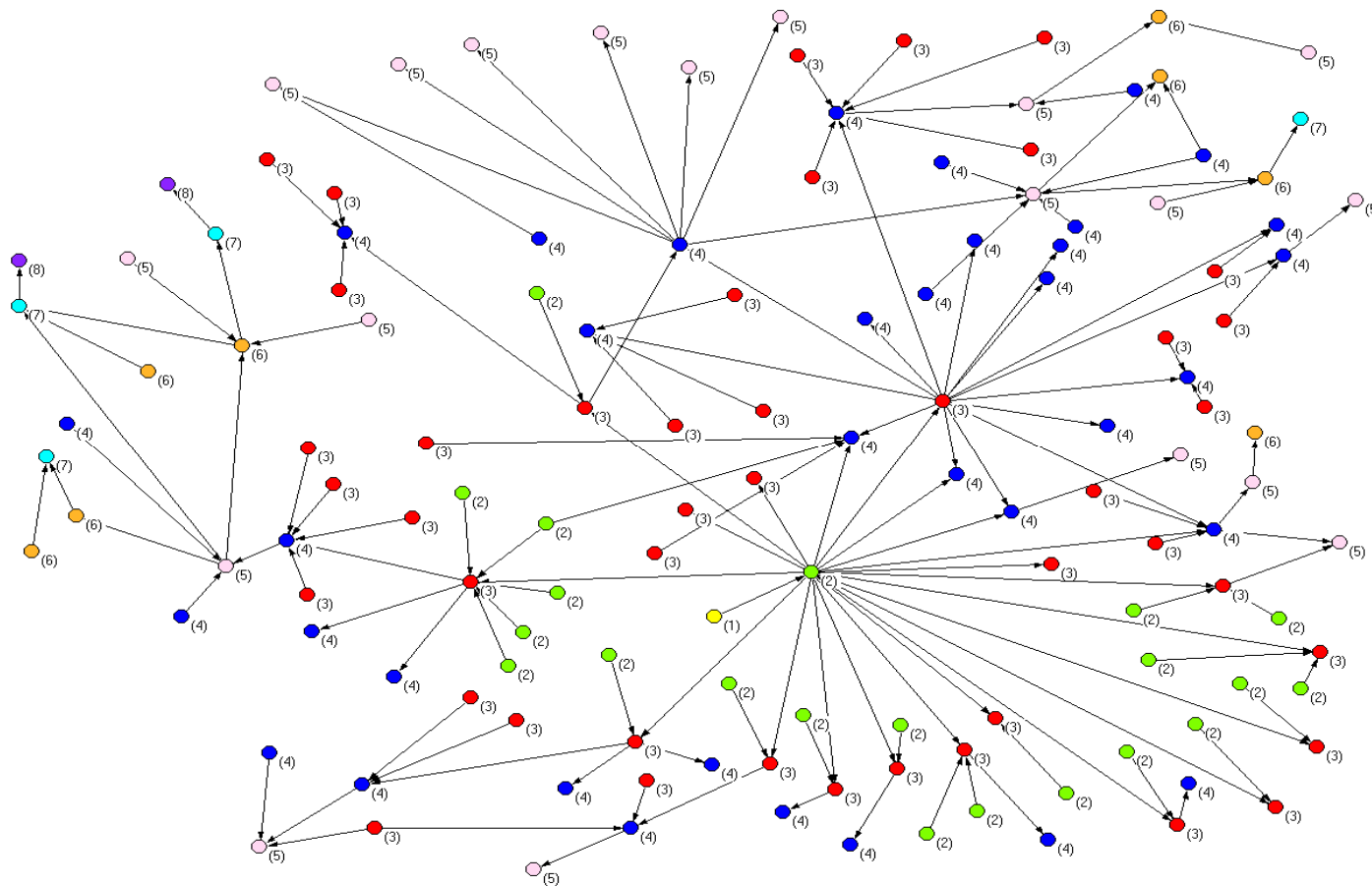


Figure 5b: Genealogy of ECI Telecom by generation (no labels)

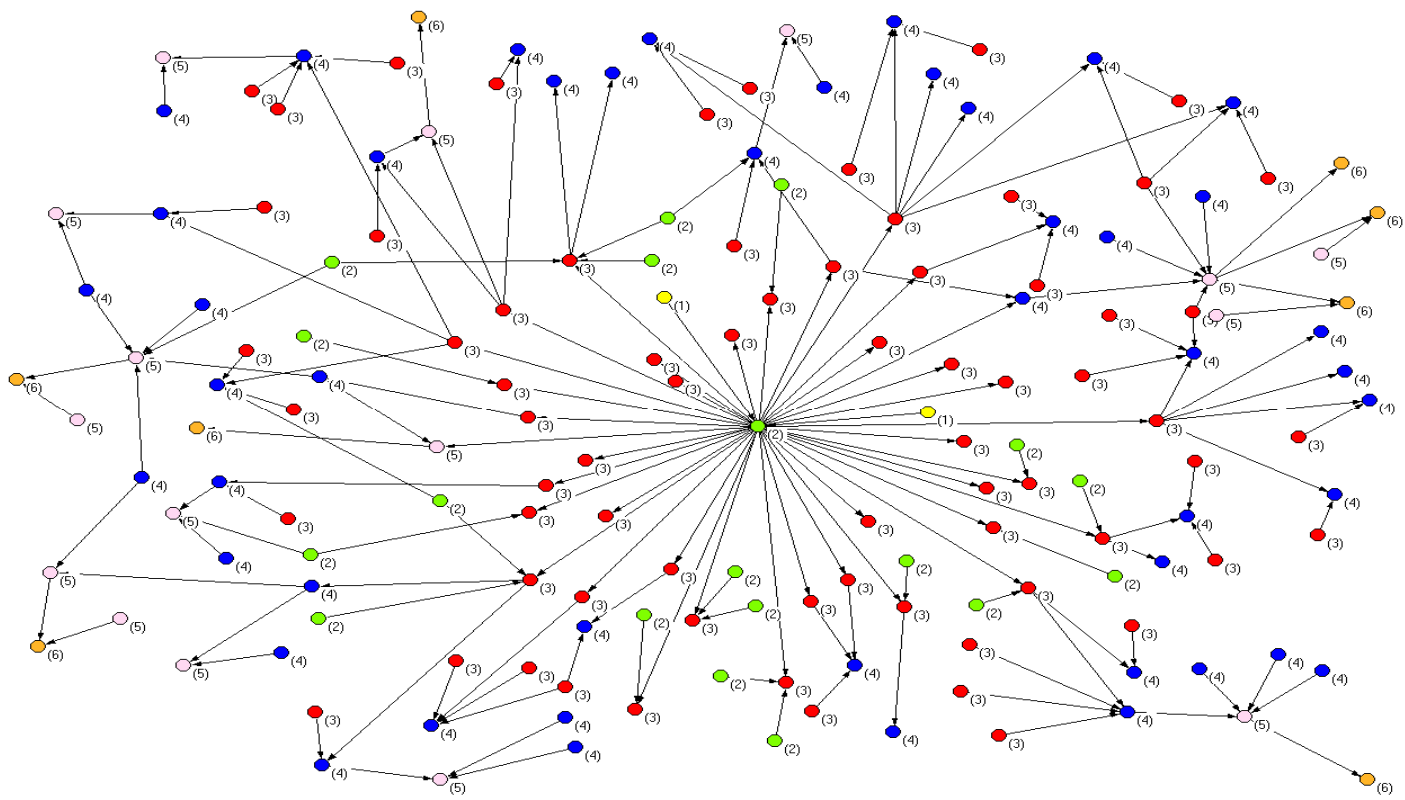
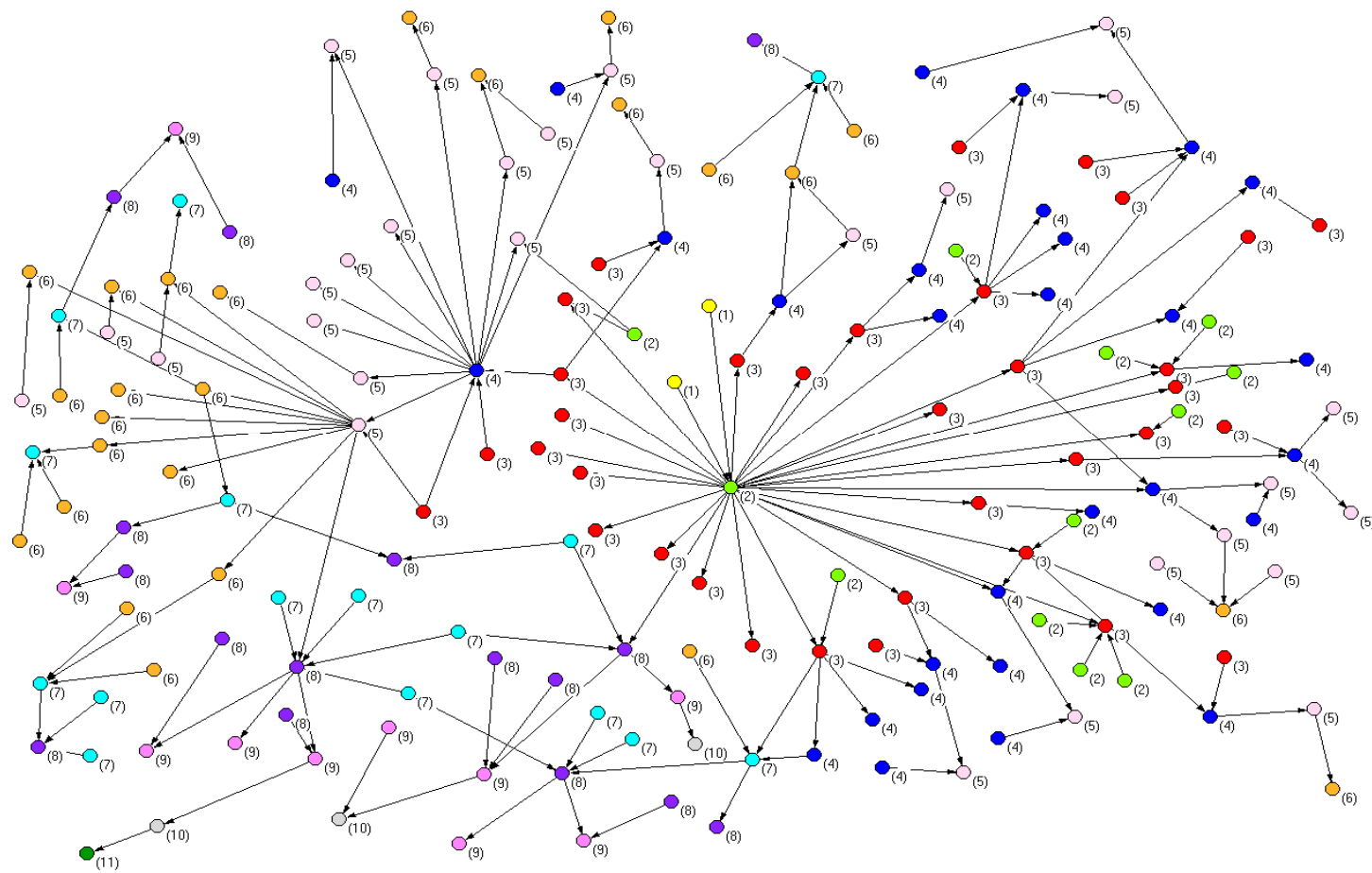


Figure 6b: Genealogy of Fibronics by generation (no labels)



Appendix 1: The Setting: The Israeli Information Technology and Communication (ITC) Sector

The Israeli Information Technology and Communication (ITC) Sector

The present study was conducted on the Israeli information technology and communication sector, the largest in the country's hi-tech industry in terms of number of firms (852 firms as of August 2005) and capital raised. Israel is widely recognized as a technological innovator (Bresnahan, Gambardella and Saxenian, 2001; Breznitz, 2005). Hundreds of startups are developing a variety of new technologies related to information processing, and many are active in the field of telecommunications. Areas in which these firms excel include Internet applications, broadband, local area networks (LANs), digital wireless, opto-electronics, video and image processing, satellite communications, network management, network security and telemedicine. The Israeli telecommunication industry has consistently been attractive to foreign investors. Many leading multinational telecommunication firms (such as Motorola, Texas Instruments, Cisco Systems, Broadcom, AVAYA, Nortel and 3com) have invested in the Israeli market, mainly through acquisitions or R&D subsidiaries. About 150 dedicated hi-tech venture capital funds operate in Israel. Indirect investment in Israeli telecommunication firms' have also been made by institutional and private investors who purchase shares of Israeli companies traded on the New York Stock Exchange, as well as in London and on other European exchanges. Furthermore, Israel is one of the countries with the highest number of firms traded on the NASDAQ. Israeli IT and telecommunication firms on the NASDAQ are world leaders in areas such as Internet security, value added service solutions, billing solutions and customer care services, VoIP technologies, fixed wireless access technologies, telecommunication services via satellite, optical and copper networking solutions, data and ATM, etc.

The emergence of Israel's ITC sector is embedded in the industrial policy of the last 40 years of mobilizing existing and emerging capabilities and resources to ensure the country's economic development. Thus, in the setting of the institutional technology policy that began in the 1960s ample industrial R&D funds have been provided for technological innovation and to a lesser extent for technological infrastructure (Breznitz 2005). The backbone of this policy has been the development of local innovative

capabilities, the creation of a local venture capital industry and various incentive programs for entrepreneurs (Avnimelech and Teubal, 2004). Altogether it has been instrumental in promoting the development of the ITC sector and its subsequent success in the global market. Furthermore, innovative R&D has led to technological developments within areas linked to national security, and products and technologies that originated in Israel's military-industrial complex are accounting for a large share of the country's exports. At the same time specialized technical units of the Israel Defense Forces (IDF) were converting technologies from military to civilian use and have become a major source of entrepreneurs who are founding the most successful Israeli ITC firms (see also Breznitz 2004, de Fontenay and Carmel 2004). Breznitz's (2005, 2006) study of the historical development of the Israeli ITC sector reveals that the government's R&D policy has overemphasized innovation diffusion at the expense of building infrastructure capabilities. It has tapped on the abundant R&D skills, mainly at the universities and in the IDF, and spurred activity in civilian industrial R&D.

Various studies (Avnimelech and Teubal, 2004; Breznitz, 2005; de Fontenay and Carmel, 2001, 2004) have noted that the unique clustering capabilities of the ITC sector are closely linked to the nature of Israel's human capital. The ample reservoir of educated and highly skilled ITC professionals originated from several sources: they are graduates of the science and technology faculties of the research universities, immigrants from the former Soviet Union, ex-military personnel from the IDF's technological and R&D units, and expatriates. Breznitz (2005) contends that in addition to providing highly skilled labor and spin-offs, the IDF contributes to the success of the ITC sector by providing a collaborative public space. Furthermore, the government's Technological Incubators Program, provides comprehensive institutional support in the form of financial capital, infrastructure, business connections and training for Russian immigrants who plan to spin-off their own startups (Frenkel, Shefer and Miller 2005). Other sources of entrepreneurship are Israeli expatriates who work for global multinationals such as Intel, IBM, Motorola, Microsoft and Sisco, or in leading ITC clusters such as Silicon Valley. These transnational entrepreneurs create important bridges between the local ITC industry and the global market. Furthermore, the geographic clustering process is also facilitated by the strong venture capital industry that is co-evolving with the ITC sector

and has the ability to create links to global financial markets (Avnimelech and Teubal 2004).

Appendix 2: The History of the Founding Firms

The following brief accounts describe the genesis events that formulated the entrepreneurial values of the six founding firms.

I. Tadiran. The firm was established in 1962 as a merger between two firms, Tadir, a military communication equipment producer (established in 1951) and RAN, a battery producer (established in 1931). The merger was carried out by a leading holding company – Koor Industries Ltd., which at that time owned them both. Tadir was considered a pioneer in military communication equipment in Israel, in terms of technology and production systems. It specialized in the development and production of various military tactical communication systems produced primarily for the Israeli security forces. RAN was the exclusive battery supplier for the allied forces in the Middle East during War World Two, and following Israel's independence (1948) became a major supplier of its defense forces. The Ministry of Defense further increased its stake in RAN by acquiring minority shares (1957). Soon after (1960), RAN was acquired by the Histadrut, * through Koor, its industrial group, which until the 1990s controlled the lion's share of the industrial sector in Israel (Maman, 2004).

The new firm, Tadiran, became a one-stop shop for military communication equipment. Koor, its holding company used Tadiran as a hub for its strategy of diversification through new technologies and knowledge acquisition and mergers. In the 1970s Tadiran consolidated its structure into three major divisions: (1) The Mechanics and Electrical Division, including the battery factory, home appliances, mechanical manufacturing, and radio and television manufacturing; (2) The Electronics Division, including military electronic equipment, semiconductors, and crystals; and (3) The Telecommunications Division, including switchboards and electronic communication hardware. During the 1970s and 1980s Tadiran expanded its international markets and

* The Histadrut, the major labor union in Israel, also owned several of the country's largest industrial groups until the 1990s.

also won major contracts with the IDF. It also demonstrated technological capabilities and commitment to innovation by independently developing advanced military electronic systems, including a mini remote piloted vehicle (MRPV). Under Koor, the growth strategy of Tadiran during this period was mainly internal, and included a spin-off (Tadiran Electronic Systems). As one of the largest organizations in the country, it was considered not only an innovative firm but also an attractive working place for technicians, engineers and for many graduates of the security forces. Consequently, spin-offs were relatively rare up to 1988 and only three independent firms were established by former Tadiran employees.

Starting in the late 1980s Koor began to encounter serious financial difficulties. During the first half of the 1990s Koor divided Tadiran into several smaller firms, and the original founding firm, Tadiran Ltd, ceased to exist.

II. Telrad Networks. The historical path of Telrad Networks (established in 1951) was shaped by its founder and first owner, Koor Industries Ltd. Since Koor, as noted earlier, was owned by the Histadrut (the labor union), providing employment for newcomers to Israel was the major priority of the new-born company rather than profits. For Telrad Networks, like Tadiran, being part of Koor Industries at the peak of its economic and political strength (from the 1950s to the 1980s) meant a relatively stable environment with limited competition. Telrad Networks started to develop and manufacture telephones and later hardware architecture for all local, transit and international gateway exchanges. The firm enjoyed the privilege of having non-competitive institutional markets such as the defense market and the national communication company, Bezeq. Telrad's marketing efforts were aimed toward the local market, which it actually controlled till the early 1990s. Its core knowledge has been acquired through agreements with foreign firms such as GEC, STR and Nortel (which later, in 1996, acquired 20% ownership in Telrad Networks). The knowledge agreement with Nortel opened the doors to the digital communication systems for Telrad Networks and strengthened its control in the local market. It also paved the way for entry into a new area of research and development and turning into a more modern hi-tech firm. Although Koor's crisis of the mid-1980s bypassed Telrad, the company entered the hi-tech boom

period unprepared to adapt to the fast-growing technologies, price drops, and saturation in the local market for line telephones.

In the early 1990s, a few years after the crisis, Koor Industries itself underwent a privatization process and is now controlled by the Claridge Group. With the new values that the new owner brought to the firm, workers' welfare and loyalty to the organization became secondary to competitiveness and profitability. From a firm of 3200 employees and a market value of \$800 million, Telrad had turned into an employer of 530 workers by the time it sold 21% of its shares to Fortissimo Capital in 2004 for only \$21 millions. Under its new leadership, Telrad has slowly regained a leading position in the communication sector.

In sum, in contrast to Tadiran, which did not survive the financial breakdown of its owner, appropriate knowledge acquisitions and a non-competitive market helped Telrad Networks to safely bypass this difficult period. However, this strategic path led Telrad to a crisis when the local and global markets changed and the continuity established by the founding company was upset by new owners and by a new strategy.

*III. ECI Telecom**: The firm operates today in three major fields: Optical Networks, Broadband Access, and Data Networking. Like Tadiran, it started as a merger of two relatively small companies in the early 1950s. The first, the American Company for the East, dealt with consumer electronics (radio and testing equipment), and the second, Radio Clipper, was a manufacturer of radios and record players. The merged company radically changed its core business when a group of Air Force veterans joined it and launched military electronic R&D and product development. Since then, ECI (Electronic Corporation of Israel) Telecom has been dependent on the institutional defense market. A second turning point was in the late 1970s when ownership changed; ECI was acquired by Clal Industries and Investments Ltd. and changed its strategic course of action, investing all its available resources in R&D and targeting its products to the civilian market. It changed its strategy from producing cost-plus projects for the military institutional market to the global competitive market. During the 1990s the firm led the world **DCME** market (90% of the global market). At the same time, it continued to grow by also entering the **SDH** and **DCME** markets and by merging with Tadiran

Communications. Towards the end of the 1990s the DCME market shrank dramatically and the revenues from the new products, SDH and DCME were insufficient at that time to cover the losses. This crisis, which occurred only few months before the hi-tech bubble burst, forced the company to reformulate its core business and to downsize. Shortly before the crisis ECI Telecom decided to convert to a holding company with independent subsidiaries, but following the crisis, it switched back to its previous structure.

IV. RAD Data Communications. RAD Data Communications is the cornerstone of the RAD Group, a family of independent companies that develop, manufacture and market solutions for diverse segments of the networking and telecommunications industry. Unlike ECI Telecom, Telrad and Tadiran, the founding parents of RAD Data Communication are still the controlling owners and their strategic decisions still have a great impact on the evolution of their group and perhaps the whole genealogy. Formally, the first company of the RAD genealogy was Bynat, an electronic components company founded by Yehuda Zisapel. A few years later, having business experience and financial resources, he called in his brother, Zoar Zisapel, who had served as the chief scientist of one of the most prestigious military technical intelligent units, and together they established RAD Data Communications. Since its establishment RAD Data Communications has founded 20 new ventures, six of which are traded on the NASDAQ. The others have been sold or are still privately held by the group's founders and several venture capital firms. Although the group is known for its successful exits, the founding company RAD Data Communications has never tried to go public and is used as a lever for the strategic moves of its founding fathers.

The RAD Group has no holding company but is strategically guided by its founders. Each firm in the RAD Group operates autonomously under a common strategic umbrella. According to the founders, this decentralized approach maximizes the advantages inherent in smaller business units, such as flexibility, entrepreneurial spirit and managerial focus. A new firm is established when a market opportunity is identified that highlights a new technology, a marketing approach or a corporate culture which does not exist in any of the other firms. RAD Data Communications usually matches the innovative idea with a prospective founder, either from within or outside the group and provides the major resources and strategic guidance for the firms founded under its

auspices. In other words, RAD Data Communications consistently plans to found new firms and rarely resorts to mergers, acquisitions or strategic spin-offs.

V. *Fibronics*. The firm was founded in 1977 and has focused on developing fiber optics technology. Fibronics was founded by two American investors, Morris Weinberg and Steve Adler and Uzia Galil, who is considered to be the pioneer of the Israeli Hi-Tech industry since he founded the leading electronic companies: Elsinet, Elbit, and Elron in the early 1970s'. Fibronix experienced a technological and business breakthrough during the early 1980s', when Motti Gurra, its CEO then, identified the potential of enhancing communication technologies via fiber-optics. Fibronics success, in particular its IBM supporting 'multiplexer' products, which were considered an innovative technology at the time, lead in 1984 to an IPO in the NASDAQ. However, Fibronics success was short lived, as internal conflicts within the company lead Gurra to leave the company and to found Adacom, its major competitor. Gurra attracted many of Fibronics veterans and left his previous company in disarray. The late 1980's and early 1990s' brought about a broader use of fiber-optics and Fibronics positioned itself as leading provider of innovative technology for fast communication networks. In the heydays of late 1998s', Fibronics employed approximately 500 people and its annual sales reached approximately \$70 million. During the 1990s', the fiber-optics market experienced a slow-down, with the introduction of alternative technologies that improved the existing wire communication infrastructure. This lead to another crisis as Fibronics practically ignored the development in the market and continued to rely and develop only products associated with the fiber-optics standard. Following the crisis, Fibronics was sold to Elbit Systems in 1994.

V. *Comverse*. The first company in this genealogy, Efrat Future Technologies, was founded in 1983 by Kobi Alexander, an investment banker with the American company Shearson Lehman, together with Boaz Misholi and his brother-in-law, Yechiam Yemini, who became Efrat's chief scientist. When the product they were making was just about ready for the market in 1984, the three men set up a company, based in Woodbury, New York, called Comverse, a play on the words 'communication' and 'versatility'. In 1986, Comverse conducted its first public issue in the US. Subsequently, when Comverse became mired in difficulties, Misholi sold his shares to Alexander and left the company. At the end of the decade, Comverse moved over to developing voice mail systems for large telephone companies, and in the 1990s, it began to experience rapid growth that positioned it firmly as a world leader in the market and one of Israel's largest NASDAQ-listed firms. Being aware that Comverse was offering an innovative product and had giant competitors such as AT&T, Alexander focused on international markets, especially Europe, and enjoyed great success with the Trilogue product, which allowed cell phone callers who were unable to reach a party they were calling, to leave a message in a voice mailbox. In the early 1990s Comverse began marketing the AudioDisk, a digital surveillance product intended for use by police and intelligence agencies in the recording and storing of wiretap material. Sales were strong and accounted for half of Comverse's revenues in 1993. Because of the discreet nature of the product, AudioDisk was not as well known as Trilogue, and in February 1994 the entire surveillance business was broken off and housed in a new subsidiary called Interactive Information Systems Corporation. Two years later, the company changed its name to Comverse Information Systems Corporation. In 1999 Comverse Technology, as it was now called, reorganized its operations into two divisions: Comverse Infosys (a merger of Comverse Information Systems with Comverse InfoMedia Systems) and Comverse Network Systems Inc.

While Comverse Information Systems quietly sold its AudioDisk systems, as part of the Comverse Infosys division, Comverse Network Systems Inc. was thriving with its wireless voice messaging systems, spurred by the tremendous popularity of cell phones in the late 1990s. However, with nearly three-quarters of its \$1.2 billion in revenues coming from the sale of mobile mailboxes, and the cell phone market reaching saturation,

Comverse Technology was in danger of having too many eggs in one basket, voice mail. Management thus began to aggressively pursue acquisitions of promising technologies in the hope of developing new products and achieving some diversification. In the process it also added assets to Comverse Infosys. In July 2000 it acquired Loronix Information Systems Inc., a company that developed software-based digital video recording, networking, and live Internet video streaming technology. From Loronix came a digital video monitoring system that was used by government agencies, such as the US Department of the Treasury, as well as commercial customers, including Mohegan Sun Casino and FedEx.

Comverse Technology completed several other acquisitions, prompting management in 2001 to reorganize the company again, this time splitting it into five divisions, one of which remained Comverse Infosys. In many respects Comverse Infosys did not fit the rest of the company, because it sold its products to an entirely different market than the telecommunications companies that bought Comverse's voice and data messaging services. It was not surprising therefore, that management would begin looking for a way to split off the security unit.

An opportunity arose following the terrorist attacks against the US on September 11, 2001, when the need for all security products increased dramatically. Although the demand for initial public offerings was weak due to a struggling economy and depressed stock market, Alexander felt the time was right to sell shares of Comverse Infosys in a 'carve-out' arrangement that would leave Comverse Technology with a majority stake in the company while unlocking shareholder value. Thus, in February 2002, Comverse Infosys was renamed Verint Systems, Inc. and prepared to go public. Media assets housed under Comverse Media Holding Inc. were sold back to the parent company, while at the same time Verint, through Lorinix, beefed up its video surveillance business with the acquisition of the digital video recording business of Lanex, LLC. Alexander assumed the chairmanship of Verint, while Dan Bodner served as president and CEO, positions he had held since Comverse Technology established Interactive Information Systems in 1994. In 2005, Comverse Technology comprised four units: Comverse, Verint Systems Inc. (formerly Comverse Infosys), Startel and Starhome.

In sum, Comverse's commitment to ongoing research and development is very high (today, more than 1,600 members of its global workforce are dedicated to R&D with more than 25% of its revenues invested annually). But, in contrast to RAD Data Communications and due to strategic considerations, Comverse acquired many firms and earned important knowledge and experience from them.