

# Network Theory: The Basics

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# Roadmap

- 10 big claims for networks
- What is a network
- What do networks do
- Some examples for innovation

# 10 big claims





1. Networks create social capital for individuals (Burt 1992; Bourdieu 1985) and communities (Putnam 2000; Portes & Sensenbrenner 1993)
2. Networks create status (Podolny 1993) and category (Zuckerman 1999) differences in markets
3. Network forms of organization are an alternative to markets and hierarchies (Powell 1990)
4. Networks are the defining feature of “innovative regions” such as Silicon Valley (Saxenian 1984; Owen-Smith & Powell 2004; Fleming et al 2007)
5. Networks are the locus of innovation in high-technology industries (Powell et. Al 1996; Stuart et. Al 1999; Ahuja 2000; Owen-Smith et. al 2002)
6. Networks create trust and increase forbearance (Piore & Sabel 1984; Uzzi 1997)
7. Networks inspire conformity in thought and action (Galaskiewicz 1991; Mizruchi 1992)
8. Networks shape the diffusion of technologies (Rodgers 1962; Coleman et al 1966) and organizational practices (Davis 1991; Strang & Macy 2001)
9. Networks create individual tastes and preferences (Mark 1998)
10. Networks ‘embed’ transactions in a social matrix, creating markets (White 1981; Baker 1984; Granovetter 1985)

**BUT**

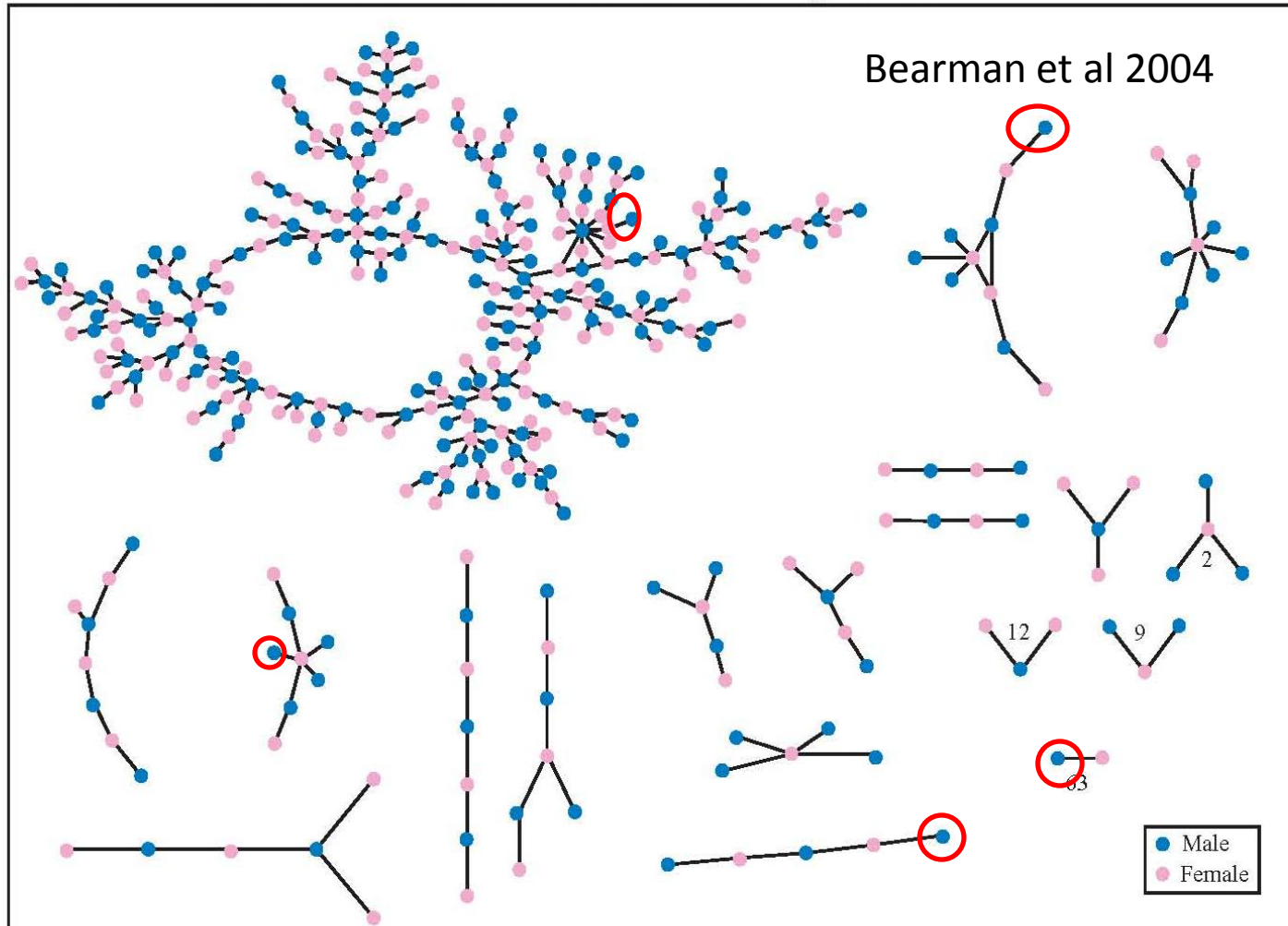
**WHAT IS A NETWORK?**

# **A concrete (measurable – more on this later) pattern of relationships among entities in a social space**

## Examples:

- (1) Social networks among individuals: friendship, advice-seeking, romantic connections, acquaintanceship 
- (2) “Formal,” contractual relationships among organizations: strategic alliances, buyer-supplier contracts, joint ventures etc. 
- (3) “Informal” inter-organizational relationships flow through people: director interlocks, employee mobility, social networks that cross organizational boundaries 
- (4) Affiliations, shared memberships that suggest connections: trade associations, committee memberships, co-authorships etc. 

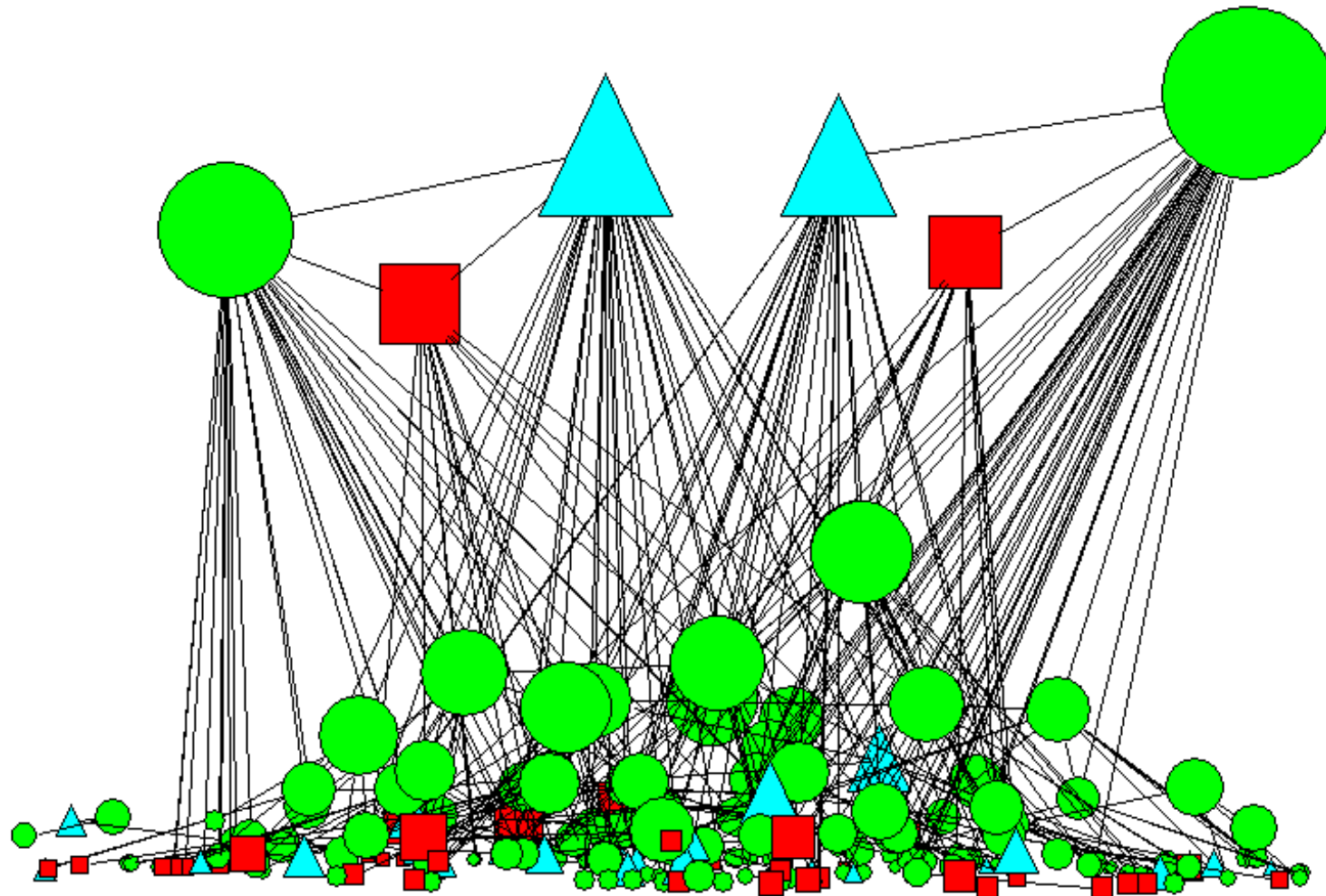
# The Structure of Romantic and Sexual Relations at "Jefferson High School"



Social network example



# The Boston Biotechnology Knowledge Community



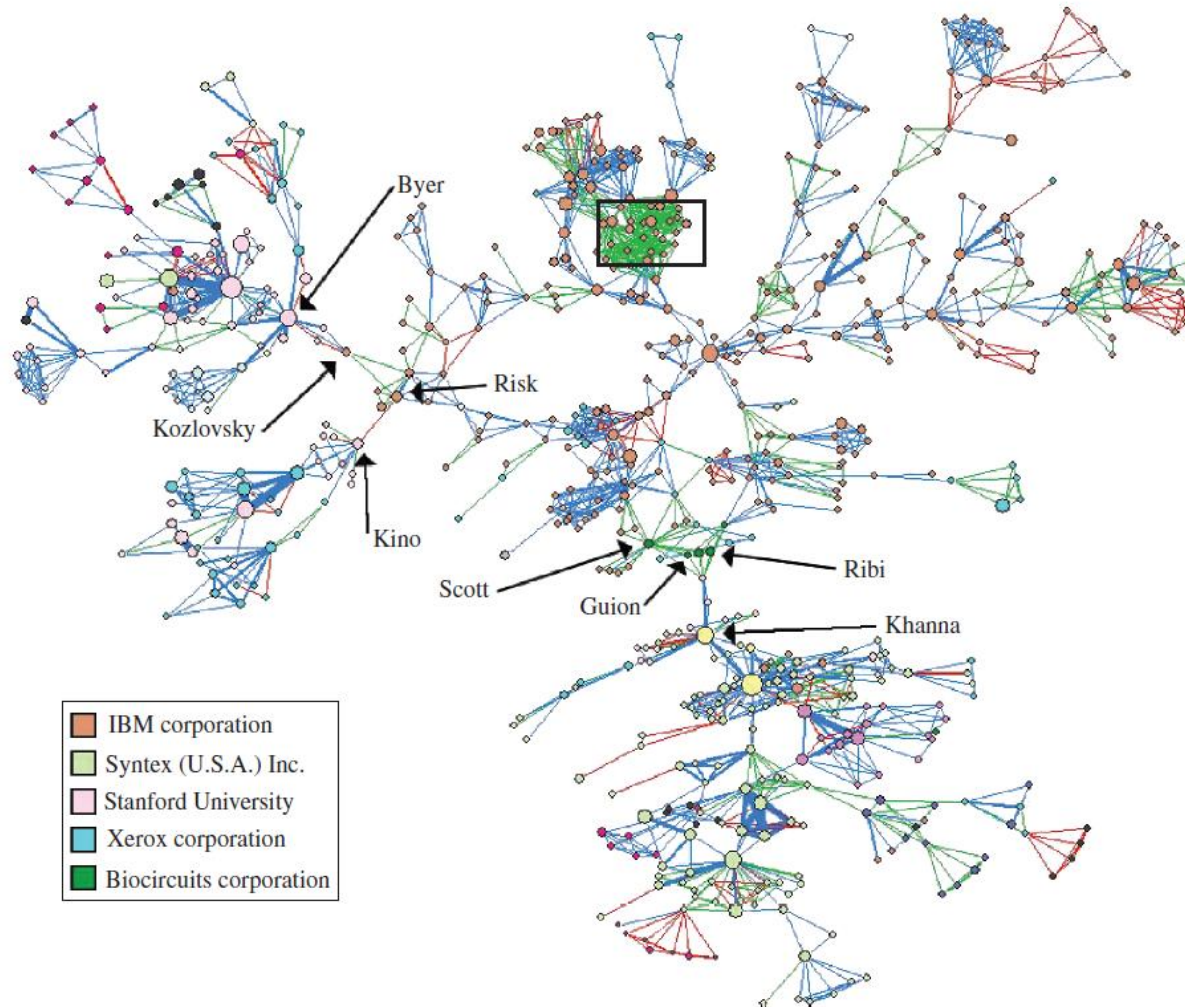
Triangles = Universities, Squares=Hospitals & Research Institutes, Circles=Firms. Ties are strategic alliances. Adapted from Powell et al 2007

Formal network example





Figure 1 Inventors of Silicon Valley's Largest Component in 1986–1990 by Assignee and Importance of Inventions



Fleming et al 2007

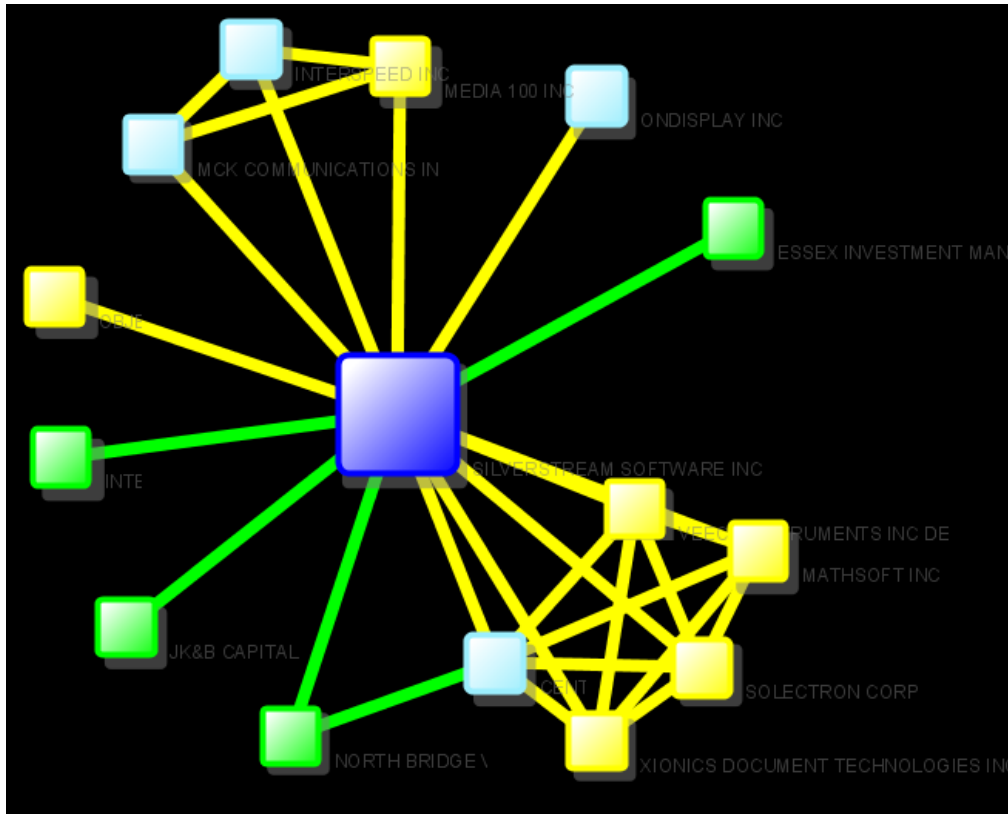
Notes. Node sizes reflect the number of future prior art cites to an inventor, normalized by the number of collaborators (future prior art cites correlate with value, see Albert et al. 1991). Tie width indicates number of collaborations, tie color indicates age of tie (red is five years prior, blue is two to four years prior, and green is prior year), and colors indicate assignee. Boxed area provides example of highly clustered inventors. Note that the figures do not illustrate the thousands of other (by definition) smaller components in each region; inventors need not connect to any extant component – or even another node. They can connect to small components, such as dyads or triads, or work their entire careers in complete isolation. Graphed in Pajek with Kamada-Kawai/Free algorithm (Batagelj and Mrvar 1998). Adapted from Fleming and Marx (2006).

Informal network example



# Two Market Segments: Public Equity & Private Equity

## Two Observed Networks: Interlocks & VC Syndicates

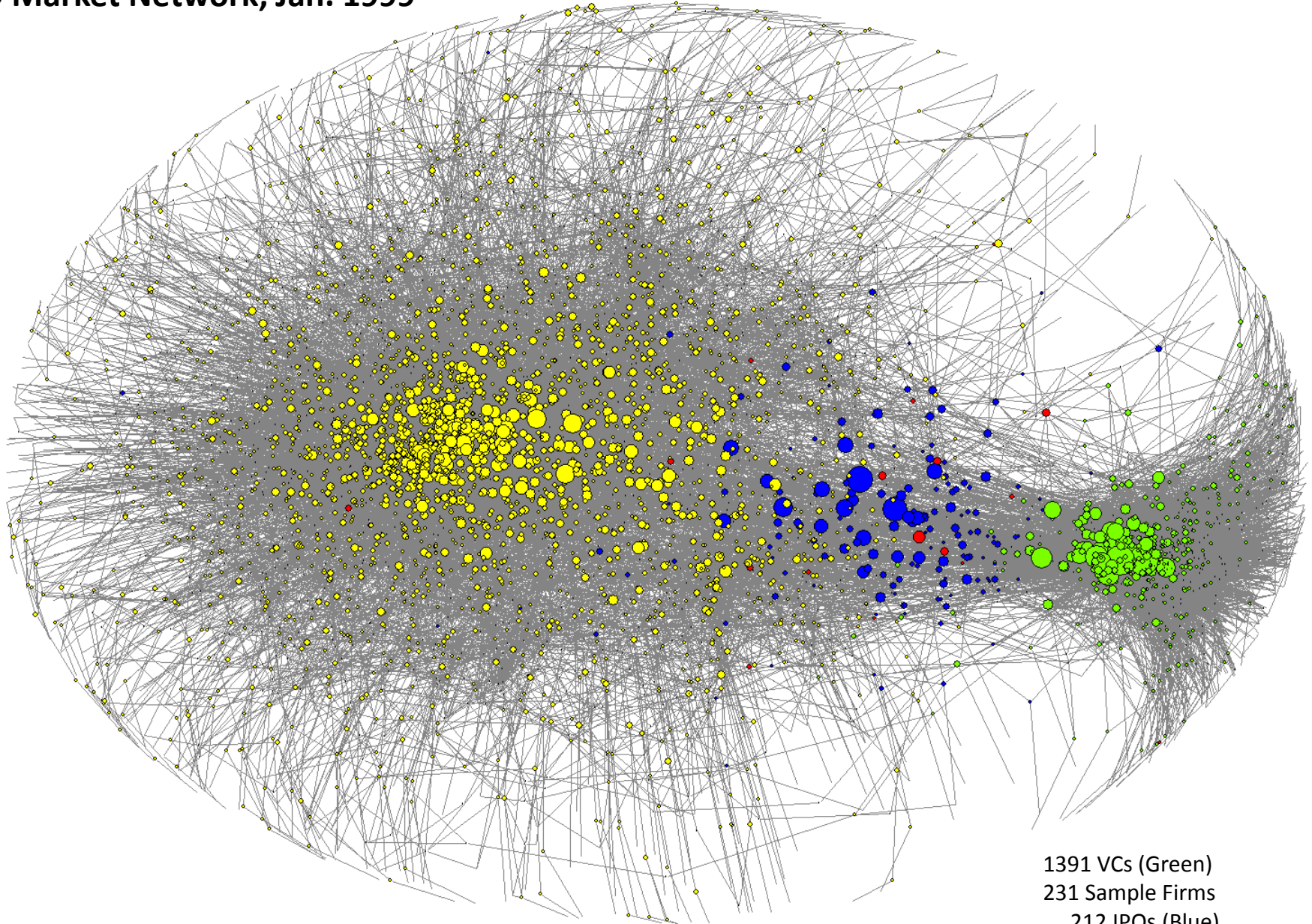


Ego Network for Silverstream Software of Burlington, MA.

- Filed S-1 6/11/1999
- IPO August 1999
- 10 Interlocks (Yellow Ties)
  - 4 to other firms in IPO pipeline (Cyan Nodes)
  - 6 to publicly traded companies in same or related industries (Yellow Nodes)
- 4 VC Investments (Green Ties)
- Acquired by Novell in 2002

Ego Network: Formal and Informal Ties

# IPO Market Network, Jan. 1999



27,126 Ties 6507 Nodes

Full Structure: Formal and Informal Ties

- 1391 VCs (Green)
- 231 Sample Firms
- 212 IPOs (Blue)
- 29 Withdrawals (Red)
- 4875 Public Companies (Yellow)

**WHAT DO NETWORKS DO?**

# Many effects, at multiple levels of analysis

Three key mechanisms:

(1) Resource and information channels.

“Network pipes”

(2) Status signaling and certification.

“Network Prisms”

(3) Social Influence. Network “peeps”



Some networks and mechanisms admit more strategic manipulation than others. Networks offer benefits but relationships can also carry social obligations that bind, and sources of influence that blind.

# Network Pipes & Innovation

- Best developed line of work.
- Focus is discovery
- Innovation is a process of recombinant search
- Centrality offers access to information
- Challenges of redundancy

## **A Few Examples**

Burt (2004) -- Where do good ideas come from?

Owen-Smith & Powell (2004) -- Knowledge Networks in Boston Biotechnology

Ahuja (2000) – Brokering, Direct, and Indirect ties in the international chemical industry

# Network Prisms & Innovation

- Less well developed tradition
- Focus is discovery or adoption
- Innovation is a risky, non-conformist behavior
- Status confers freedom of motion under some conditions and locks participants into strategies under others
- Challenge is conformity

## **A few examples**

- Phillips & Zuckerman (2001) – Middle Status Conformity in markets for legal services and investment advice
- Podolny & Stuart (1995) – Technology “niches” in the semi-conductor industry and the probability of follow-on innovations
- Stuart & Podolny (1996) – local search, technology niches, and innovation in Japanese semi-conductors

# Network Peeps & Innovation

- Oldest tradition
- Focus on adoption and diffusion not discovery
- Adoption is a matter of access, influence, and visibility
- Challenge of groupthink

## **A few examples**

- Rodgers (1965) – Diffusion of innovations
- Coleman et al (1966) – Physician's adoption of new medical innovations
- Davis (1991) – Corporate adoption of “poison pill” and “golden parachute”



# Future directions & things I didn't cover

- Contingencies (e.g. effects of uncertainty or competition)
- Dynamics (tie formation and innovation endogenous?)
- Tradeoffs (e.g. networks that facilitate discovery may hamper adoption)
- Other Levels of Analysis (teams, regions, nations, industries)