Technology Investing in the New Age
Plenary Session
Workshop on Interconnections within High Speed Digital Systems
Santa Fe, New Mexico

May 5, 2004
Background Context: *Historical Innovation Coming Largely From Research Labs*

- **Death of Innovation,** April 1997, Business Communications Review
- **Bell Labs spun out with Lucent**
  - what about the future?
  - 1% of gross revenues for basic research: fluctuations in gross revenues?

**Examples of Bell Labs Technical Innovation**
- Transistor
- Information Theory
- UNIX
- C and C++ Software Programming Languages
- Maser/laser
- Cellular telephony
- Optical fiber
- RJ11/RJ45 connector
What Is the Problem?

- **The Economics of Innovation**
  - True technical innovation fuels small business economic growth
  - Technical innovation is imbedded in new products that meet real customer needs, generate profits and revenues in growing markets, and can continue to fund innovation
  - Small businesses are a major source of new jobs, new wealth

- **The Nature of Innovation**
  - True Innovation Is Rare: Einstein Had Two-Three Ideas
  - Relatively Easy to Infringe/Coopt Innovative Ideas at an Early Stage by patents, trade secrets, hiring people

- **The Problem with Funding Innovation**
  - Funding For basic research is always difficult to defend
  - Increasing scrutiny of basic research funding
    - Universities
    - Government laboratories
    - Corporate laboratories
  - Venture capital Is not funding innovation

- **What Are New Funding Sources for Basic Research?**
  - Angel investors
  - Restructured venture capital funds
If Not Venture Capital, Who Will Fund Innovation?

- US Government
  - DOD: DARPA et al
  - NSF
  - DOE
  - NIST
  - SBIRs
- Universities via endowment
- Corporations
  - research labs
  - applied research in product groups
  - universities
Innovation Life Cycle Issues for Computers

- Innovation occurs in cycles or waves
  - Innovation <-> consolidation
  - Different design points and different technologies lead to new successful business in every cycle

- Computer Industry Cycles
  - 1965: peak sales for mainframes--IBM
  - 1972: peak sales for minicomputers—DEC, HP
  - 1979: peak sales for personal computers--Apple
  - 1986: peak sales for workstations--SUN
  - 1996-onward: cellular phones and workstations based on RISC/UNIX/LINUX—Nokia, Dell
Innovation Life Cycle Issues for Networking

- **Innovation occurs in cycles or wave**
  - Innovation <-> consolidation
  - Different design points and different technologies lead to new successful business in every cycle

- **Data networking**
  - 1965-1975: dial up and private line modems, hard wired terminals—Paradyne, Codex, General Data Comm, Racal Milgo
  - 1975-1985: X.25 Wide Area Networks, T1—Hughes, Telenet, Timplex, NET
  - 1985-1995
    - Workgroup Ethernet hubs: 3Com, Synoptics
    - Frame Relay and ATM Networking: Stratacom Fore Systems
    - Routers: Cisco, Wellfleet
  - 1995-2005: Switched Ethernet, routers—Foundry, Juniper
  - 1995-2005: storage networking—Veritas, EMC, Network Appliance, Brocade

- **Voice networking**
  - 1965-1985: stored program control mechanical switching—Lucent
  - 1975-1995: digital switching—NorTel
  - 1995—onward: Excel, Telica
Venture Capital Structural Issues

- **Venture Fund Life Cycle**
  - Seven year life: need to invest in first three to four years to harvest by the end of year seven

- **Venture Capital Staff Backgrounds**
  - Strong bias toward investment banking, management consulting, operations: not strong technically, little background in basic research

- **Serial vs Parallel Investing**
  - Invest in those that made money previously: does this lead to funding innovation? More of the same, incremental innovation

- **Boom vs Bust**
  - $1M valuation per engineer in 1999—no sales, $10M-$100M in cumulative operating losses
  - $5M-$10M per round in 2002-2005—money for sales and marketing and manufacturing, no money for funding technical innovation
## Venture Capital Fund Educational Background of General Partners

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Number of GPs</th>
<th>Percent of GPs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (20 A-list Venture Funds)</td>
<td>180</td>
<td>100%</td>
</tr>
<tr>
<td>Undergraduate: Science/Engineering</td>
<td>115</td>
<td>63.9%</td>
</tr>
<tr>
<td>MBAs</td>
<td>116</td>
<td>64.4%</td>
</tr>
<tr>
<td>Masters: Science/Engineering</td>
<td>52</td>
<td>28.9%</td>
</tr>
<tr>
<td>PhD: Science/Engineering</td>
<td>10</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

* Percentages calculated based on the total number of GPs.
What Does the Evidence Show?

- Information Sources
  - Initial Public Offerings: 1993-2002
  - Select Mergers & Acquisitions: 1993-2002

- Define Innovation
  - Five point scale: T1 Highest, T5 Lowest

- Data Analysis

- Data Interpretation
Information Sources on IPOs

- **1993-2002 Initial Public Offerings**
  - Morgan Stanley Technology IPO Yearbook
  - 1303 IPOs 1993-2002
  - Discards
    - Spinoffs, Recaps: Lucent, Agere, Agilent
    - eCommerce: eBay

- **1993-2002 Mergers and Acquisitions**
  - 213 acquisitions by Cisco, Lucent, Nortel et al
  - Cisco effect: 14 acquisitions 1993-1996
# Technology Innovation Ranking

## Definitions

<table>
<thead>
<tr>
<th>Technology Ranking</th>
<th>Criteria</th>
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<tbody>
<tr>
<td><strong>T1</strong></td>
<td>New technology representing a fundamental departure from anything existing previously, whose commercialization made possible an entirely new (and important) business market</td>
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<tr>
<td><strong>T2</strong></td>
<td>Fundamental technology improvement in an existing product category (i.e., disruptive technology)</td>
</tr>
<tr>
<td><strong>T3</strong></td>
<td>Non-trivial technical improvements in existing product categories -- coming from extension of existing technologies.</td>
</tr>
<tr>
<td><strong>T4</strong></td>
<td>Modest improvement in existing technologies; i.e., by repackaging a combination of already-commercialized technologies in novel ways</td>
</tr>
<tr>
<td><strong>T5</strong></td>
<td>No new technology, but able to successfully market existing technology. Alternatively, companies developing new business models using well-established Internet technologies</td>
</tr>
</tbody>
</table>
Data Analysis Questions: Is Investing in Innovation Profitable?

- IPO valuations higher with higher technical innovation?
- Post IPO, what happens to valuations?
- Over three years or more post IPO, what about relative valuations?
# Data Analysis: IPOs By Technology Ranking and by Time Period

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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td># Companies</td>
<td>% Of Total Companies</td>
<td>Companies Per Year</td>
<td># Companies</td>
<td>% Of Total Companies</td>
<td>Companies Per Year</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>5</td>
<td>1.1%</td>
<td>1.3</td>
<td>2</td>
<td>0.5%</td>
<td>0.3</td>
<td>0.27</td>
</tr>
<tr>
<td>T2</td>
<td>15</td>
<td>3.3%</td>
<td>3.8</td>
<td>3</td>
<td>0.9%</td>
<td>0.5</td>
<td>0.13</td>
</tr>
<tr>
<td>COMBINED T1/2</td>
<td>20</td>
<td>4.4%</td>
<td>5.0</td>
<td>5</td>
<td>1.4%</td>
<td>0.8</td>
<td>0.17</td>
</tr>
<tr>
<td>T3</td>
<td>117</td>
<td>25.7%</td>
<td>29.3</td>
<td>42</td>
<td>11.4%</td>
<td>7.0</td>
<td>0.24</td>
</tr>
<tr>
<td>T4</td>
<td>301</td>
<td>66.2%</td>
<td>75.3</td>
<td>320</td>
<td>87.0%</td>
<td>53.3</td>
<td>0.71</td>
</tr>
<tr>
<td>T5</td>
<td>17</td>
<td>3.7%</td>
<td>4.3</td>
<td>1</td>
<td>0.3%</td>
<td>0.2</td>
<td>0.04</td>
</tr>
<tr>
<td>Total</td>
<td>455</td>
<td>100.0%</td>
<td>113.8</td>
<td>368</td>
<td>100.0%</td>
<td>61.3</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Source: Morgan Stanley Technology IPO Yearbook; Signal Lake Analysis
# Data Analysis: IPO Companies For 1997-2002

**Mean and Median Per-Company Values As of 12/31/2002***

<table>
<thead>
<tr>
<th>Technology Ranking</th>
<th>Mean 12/31/02 Value $MM</th>
<th>Mean Index</th>
<th>% Change versus Original IPO Value</th>
<th>Median 12/31/02 Value $MM</th>
<th>Median Index</th>
<th>% Change versus Original IPO Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1/T2</td>
<td>$1,039</td>
<td>266</td>
<td>-2.2%</td>
<td>$600</td>
<td>759</td>
<td>73.9%</td>
</tr>
<tr>
<td>T3</td>
<td>$1,210/ $726**</td>
<td>310/ 186**</td>
<td>15.0%/-34.4%**</td>
<td>$286</td>
<td>362</td>
<td>-28.1%</td>
</tr>
<tr>
<td>T4</td>
<td>$320</td>
<td>82</td>
<td>-29.8%</td>
<td>$70</td>
<td>89</td>
<td>-64.3%</td>
</tr>
<tr>
<td>T5</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Total</td>
<td>$390</td>
<td>100</td>
<td>-27.8%</td>
<td>$79</td>
<td>100</td>
<td>-62.6%</td>
</tr>
</tbody>
</table>

Source: Morgan Stanley Technology IPO Yearbook; Signal Lake Analysis

* Companies acquired prior to 12/31/02 are valued at year-end 2002 at their acquisition price
** After excluding E-Tek, MMC and Galileo
Higher Valuations and Profits Correlate with Higher Innovation

- Is Innovation More Profitable? YES
  - Higher IPO valuations accrue to the higher technical innovation ranking companies
  - Post IPO, higher valuations stick
- Changes over time in relative valuation?
  - Valuations HIGHER for higher innovation
Quandary
More background: www.signallake.com/innovation/

- Substantial decrease in the level of innovation, despite
  - $3B invested in 1993 by all venture funds
  - $50B+ invested in 2002 by all venture funds
  - Data indicating that the public financial markets reward businesses with technical innovation

- Is this due to
  - Life cycle factors?
  - Venture capital funding behavior?
Some Preliminary Throughts on Restructuring Venture Capital for Funding Technical Innovation

- **Current Venture Funds**
  - Early stage: 60%+ IRR historically—>in a portfolio of ten funded companies, two are writeoffs, six recoup their investment, and two pay for all the rest 10X
  - Mid to late stage: 30%-40% IRR historically
  - Potential for down rounds->last round owns everything: is this ethical (public markets do not allow this!)?

- **Angel Investor Funds**
  - Appropriate size and scale
  - $200K per year for 3-5 years
  - Exit: Triage or fund to commercial operation

- **Elephant Funds**
  - Disruptive innovation
  - Hundreds of millions in committed capital
  - Initial small placements, triage, those that progress to commercial success get the bulk of the funds