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Ally or Acquire? Case Studies of Compaq and Cisco as Additional Tests of the External Technology Life Cycle Model

Edward B. Roberts¹ and Wenyun Kathy Liu²

1. Introduction

In our first paper³ we proposed a dynamic theory relating alliances and acquisitions to the evolution of a technology and the market it serves. Industry structure and critical success factors change as the underlying technology evolves from phase to phase, competitive pressures exerted on a firm vary, and companies respond by adopting changing approaches to inter-firm collaboration. During the fluid phase new technology companies often form marketing alliances with established technology firms and pursue an aggressive licensing strategy to gain market recognition. The proliferation of technology startups provides an opportunity for established technology companies to obtain new technologies or enter niche markets through acquisitions or minority equity investments. Anticipating the emergence of a dominant design, companies can form standards alliances to promote their own proprietary technologies. During the transitional phase, companies with dominant designs gain recognition from the stock market, and soaring stock prices make it possible for them to acquire some of their competitors. During the mature phase, technology is well defined and competition becomes intense. Companies can form technology alliances to cut R&D costs. If a particular technology cannot be developed in-house, companies can acquire it on the open market. Marketing alliances frequently help companies target latent markets and expand into new geographic markets. During the phase of technological discontinuities the market is invaded by new technologies. Incumbents can utilize their resources to acquire the technologies needed for the newly defined marketplace. Attackers can gain market recognition through forming strategic supply alliances with established technology companies, which for the attackers is akin to the fluid phase behavior described above. In that first paper we illustrated these phenomena with a detailed case study of Microsoft, the world's leading software firm, from its origins until 2000.

In this paper we further examine this hypothesized technology life cycle model through additional case studies of two high-tech companies during the same time period as the Microsoft analysis (i.e., until the year 2000): Compaq Computer and Cisco Systems. Compaq Computer was then the No.1 personal computer (PC) manufacturer in the world and is now a major portion of HP Corporation, and Cisco Systems was and still is the leading computer networking company. Each of these companies faced unique challenges at each stage of development of its underlying technologies and markets, which in turn affected its choice and extent of use of collaborative strategies. The additional case studies illustrate varying degrees of concurrence with the hypothesized dynamic model, and raise new issues for theory building. Each company's history is synopsisized at the end of this paper in accord with the technology life cycle theory.

2. Compaq Computer

2.1 Fluid Phase (1982-1986)

Established in 1982 Compaq Computer got its name from a combination of two words: compatibility and quality. The company aimed at manufacturing high-quality IBM PC-compatibles. Unlike Microsoft Compaq entered the personal computer market without a revolutionary technology.⁴ But from the very beginning the company was first to market with new technologies developed by the leading players of the industry. Thus, in a sense, its "technology" was being "first in with high quality" for PCs. In 1982 Compaq was first to market with a portable computer, the Compaq Portable PC. In its first full year of existence Compaq shipped more than 53,000 portable PCs, and its revenue reached a record of \$329 million.⁵ It became the world's second largest supplier of 16-bit personal computers in 1984.

Other than IBM Compaq's strongest competitor in the early stage was AT&T. (Oh, how soon we forget!!) Both companies had very strong financial strength and technological expertise. Most of the other computer companies such as Corona Data Systems and Eagle Computer were small and did not constitute any strong competitive threat to Compaq. During this phase compatibility with IBM's equipment was the key to Compaq's growth. Compaq won significant market share with its first-to-market strategy, bringing new product models with a short time cycle. It introduced the Compaq Portable

PC in 1982, Compaq Deskpro in 1984, Deskpro 286 and Portable 286 in 1985, and Compaq Portable II in 1987.

During these early years Compaq engaged in very little alliance and acquisition activity. It primarily sold its products through a channel system and did not form marketing alliances. As it adopted the PC technologies developed by others, it pursued a strategy of licensing. It licensed in key PC technologies including the MS-DOS operating system from Microsoft and PC hardware technologies from IBM. For the technologies it wasn't able to license in, Compaq developed them in-house. It carried out no acquisition activity during this fluid stage.

2.2 Transitional Phase (1987-1990)

By 1987 the "Wintel" system (Microsoft's Windows and Intel's chips) had been established as the dominant PC technologies. Worldwide PC sales embarked on a road of rapid growth and Compaq was well positioned to take advantage of the PC boom. In 1989 its sales reached US\$2.9 billion, averaging an annual growth rate of 50% for the transitional phase.⁶ Compaq took over IBM's position as the No.1 PC manufacturer in the world.

During this phase competition began to mount from other computer companies such as Dell and Olivetti. Compaq did not pay much attention to the competitive threat as its products were perceived to have higher quality, hence more reliable. In the meantime Compaq continued to improve its products and bring the most advanced technologies to the market. It introduced Portable 386 in 1987, Deskpro 386/20 in 1988, SLT/286 Laptop in 1989, and LTE Notebook PC and Systempro Server PC in 1990.

Compaq began to be slightly more active in alliances than it had been in the fluid stage. It participated in a number of joint R&D agreements, joint marketing agreements, and licensing agreements. Its partners included Novell, Nexgen and Microsoft. However, its alliance strategy was hardly well thought out. In 1988 it joined the Extended Industry Standard Architecture (EISA) Alliance, created by nine IBM competitors including AST Research, Compaq Computer, Epson, Hewlett-Packard, NEC, Olivetti, Tandy, WYSE, and Zenith Data Systems. It was one of the earliest standards promotion alliances in the

computer industry. But EISA failed to become the industry standard as Intel's PCI ultimately won the battle. Compaq did not carry out any acquisitions during this phase.

2.3 Mature Phase (1991-1995)

The competition against Compaq intensified in 1990 as the clone makers began to offer the same technical quality and innovation for which Compaq had been known and they offered a much lower price to the customers. During this mature stage (Utterback⁷ refers to it as the "specific stage") customers were most concerned with price and availability as quality and functionality of the PC brands converged. Compaq Deskpros faced stiff challenges from ALR, AST, and a growing number of Asian companies that had access to the same components that Compaq used. Annual growth rate dropped below zero in 1991 for the first time in Compaq history. The competition forced Compaq to change its product strategies.

The new CEO, Eckhard Pfeiffer, went beyond the immediate task of cost cutting – he wanted to make Compaq a top player in the industry by leveraging its worldwide presence and high-level brand recognition. Along with new distribution strategies, better customer support, aggressive prices, and a Japanese expansion, the company rebounded. In September 1992 Compaq slashed prices for its personal computers by as much as 50%, and sales jumped 75% from 1992 to 1993. By August 1995 Compaq leapfrogged into the No.1 position in overall PC sales in the United States. In the meantime Compaq devoted much of its attention to pursuing the global market. The strategy paid off – it became the largest supplier of personal computers in the world in 1994.

However, the competitive pressures from Dell, AST and other low-cost manufacturers remained strong throughout the '90s. Despite its internal efforts at cost control Compaq was forced to participate in a broader range of collaborative activities. From 1990 to 1995 Compaq took part in 61 alliances and joint ventures. Of these partnerships 57% included joint marketing arrangements and 48% involved joint research and development agreements. Licensing agreements and manufacturing operations each accounted for 10%. Given the strong customer nature of Compaq's business it is not surprising that the majority of the strategic partnerships involved joint sales and marketing agreements. The main objective of these marketing alliances was to

provide integrated solutions to meet customers' needs. To keep up with the rapid technological changes in the computer industry Compaq also participated in a wide variety of joint research and development ventures.

	R&D	Marketing	Licensing	Manufacturing	Total
1990	2	3	1	0	4
1991	2	4	2	0	9
1992	7	6	1	0	12
1993	3	8	0	1	10
1994	7	7	2	2	12
1995	10	9	2	4	18
1996	7	6	1	0	12
1997	6	9	5	4	15
1998	9	11	2	2	24
1999	3	11	2	1	17

Table 1. Compaq's Alliances and Joint Ventures (1990-1999)⁸

To establish its leadership in the entire computer industry Compaq also began to make minority equity investments and acquisitions. In 1995 Compaq acquired Thomas-Conrad and NetWorth. Both acquisitions were part of Compaq's inter-networking business strategy that aimed to enhance its ability to provide more tightly integrated enterprise-class computing systems to commercial customers. In addition to acquisitions Compaq made three equity investments. The investment in Nexgen Microsystems was undertaken to hedge against Intel's microprocessors, but failed since Intel won the battle for the industry standard. The investment in Silicon Graphics (SGI) turned out to be profitable as SGI became a leading manufacturer in high-end workstations. In the meantime Compaq was able to access SGI's advanced graphics products.

Minority Equity Investments

Company	Date	Business Description
Nexgen Microsystems	3/06/90	Manufacture microprocessors, \$25 million
Silicon Graphics	4/03/91	High-end computer systems, joint R&D, joint marketing
PureSpeech	6/21/95	Develop speech recognition products, joint R&D

Acquisitions

Company	Date	Business Description
Thomas-Conrad	10/18/95	Maker of network interface cards and hubs
NetWorth	11/6/95	Leading developer of Fast Ethernet hubs,

Table 2. Compaq's Minority Equity Investments and Acquisitions (1990-1995)**2.4 Discontinuities Phase (1996-2000)**

Compaq Computer's growth rate slowed down during the second half of the 1990s. The global PC market was deep into its maturity phase and competition was stronger than ever. Several key competitors established themselves as the industry innovators by introducing new business models rather than new technologies. Dell Computer, for example, was extremely successful with its direct sales strategy. Gateway became the only major PC manufacturer that had a company-owned retail network, which allowed for better client-oriented services. Newcomers like e-Machines stormed the market with computers 50% cheaper than the name brands. Compaq's No.1 position was in serious jeopardy.

In an effort to strengthen its leadership position Compaq became increasingly active in alliances. From 1996 to 1999 Compaq participated in 68 joint ventures and alliances. This number was an annual increase of 55% over the mature phase. However, the distribution of these alliances was similar to the previous period as Compaq continued to focus on customer relationships and technology leadership. Of these partnerships 54% included joint marketing arrangements and 37% involved joint research and development agreements. Licensing agreements and joint manufacturing operations remained unchanged at 10%. The joint R&D projects covered almost every aspect of PC technology, ranging from networking to handheld devices.

Given the deteriorating conditions in the global PC market Compaq began to expand its business into new product areas. To achieve this end it went on a shopping spree. From 1997 to 1999 Compaq bought Tandem Computers, Microcom, Digital Equipment Corporation (DEC), Shopping.com and Zip2. The first three acquisitions were targeted at improving Compaq's bottom line and growth prospects. Both Tandem and DEC were leaders in the high-end enterprise computing market, which offered a higher profit margin. Microcom was a leader in the remote access market. Concurrent with the growth of the Internet, telecommuting and portable computing, the demand for remote

access servers was expected to grow dramatically from \$3.0 billion in 1996 to \$8.3 billion in 2000.⁹

With the growing influence of the Internet in the PC market Compaq Computer became increasingly active in the Internet arena. In 1999 it formed a strategic partnership with CMGI, a leading player in the Internet economy. As part of this agreement CMGI agreed to collaborate with Compaq's research labs and business groups to develop and deploy next-generation Internet technologies. In addition Compaq sold a majority stake (83%) of AltaVista to CMGI.¹⁰

<u>Acquisitions</u>		
Date	Company	Business Description
April 10, 1997	Microcom	Remote access servers
June 23, 1997	Tandem Computers	High end standards-based enterprise computing, \$3.0 billion
Jan. 26, 1998	Digital Equipment Corp.	High-end workstations, servers, Internet search engine, \$8.4 billion
March 10, 1999	Shopping.com	e-Commerce, on-line shopping, \$220 million
April 5, 1999	Zip2	Industry standard local Internet platform

<u>Divestiture</u>		
Date	Company	Business Description
June 28, 1999	AltaVista	Internet search engine, majority sold to CMGI

Table 3. Compaq's Acquisitions (1996-2000)

Table 4. Compaq and the Four Technology Phases

	Fluid Phase	Transitional Phase	Mature Phase	Discontinuities Phase
Dynamics of the Phase	<ul style="list-style-type: none"> * 83% growth rate * Entered the market with the dominant design developed by IBM, Microsoft and Intel 	<ul style="list-style-type: none"> * 50% growth rate * Competition began to mount as companies entered the high growth market * Brought to market PCs with the most advanced technologies 	<ul style="list-style-type: none"> * 50% growth rate * Intense competition in the PC market * New producers were able to offer similar quality with lower prices 	<ul style="list-style-type: none"> * 25% growth rate * Emergence of the Internet * Competition more severe from Dell, Gateway, others * Outdated channel systems

Priorities	* Establish itself as the quality producer * Gain quick market recognition * Develop technologies that can't be licensed in	* Pursue an aggressive growth strategy * Try to influence various PC standards	* Cut prices * Control costs	* Keep up with the new technologies * Develop a better distribution system
Alliances and Joint Ventures	* Pursued a strategy of licensing in	* More active than in the fluid stage * Formed supply agreements, joint marketing, joint R&D agreements * Participated in EISA standards alliance	* Very active * Participated in 61 alliances and joint ventures * 37% joint R&D, 54% joint marketing, 15% supply agreements	* Very active * Participated in 68 joint ventures and alliances
Mergers and Acquisitions	* None during this phase	* None during this phase	* Made 3 minority investments * Bought 2 hardware companies with networking hardware technologies	* Made 5 acquisitions to expand into new product and service markets * 1 partial divestiture

3. Cisco Systems

3.1 Fluid and Transitional Phases (1984-1990)¹¹

Cisco Systems is the leading networking hardware company in the world. Its family of products allows data to be accessed by computers on the network, even across different operating systems. Founded in 1984 Cisco's first product was a router that translated e-mails from computers with different operating systems. In its early years Cisco enjoyed rapid sales growth as its technologies served a niche market. Strictly a router company, it sold 5,000 routers for a total revenue of \$70 millions in 1990.

During this phase competition was very low for Cisco. One priority was to gain market recognition. Cisco made a number of marketing alliances and supply agreements. However, it was not very active in alliances activities at this stage nor did it make any acquisitions during these early years. Cisco was able to grow rapidly without the help of alliances and acquisitions. The main reason for its early success is that its router technology was a pioneering product and there was little competition.

3.2 Mature Phase (1991-1996)

As the PC market started to take shape, the networking market began its rapid expansion in 1991. Like Microsoft Cisco had the right technologies at the right time and it took full advantage of the market expansion. From 1991 to 1996 Cisco sales grew by an average rate of 100% on a yearly basis. In 1996 the company sold 824,000 routers and net sales reached a record of \$4.1 billion, a 5,750% increase from 1990.

During this phase competition began to rise and Cisco's main competitor was Wellfleet Communications. New alternative networking technologies such as Ethernet and ATM switching products were developed by niche startups. Their presence threatened to take away some of the router market from Cisco. Cisco actively participated in alliances and acquisitions to ensure its technological and market leadership. From 1991 to 1996 Cisco participated in 27 joint ventures and alliances. Of these partnerships 47% included joint marketing arrangements, 27% had licensing agreements and 40% included joint research and development agreements. As expected from the theory most of Cisco's alliances during this phase aimed at marketing its products and developing new technologies. The majority of its marketing partners were established computer manufacturers including Apple, Compaq, DEC, IBM, NEC and Siemens.

In addition to alliances Cisco made minority equity investments in 12 technology startups. Most of these investments were part of comprehensive strategic alliance agreements. Forty-percent of the alliances included investments by Cisco, signaling that many of Cisco's partners were technology startups. Equity investments and alliances can and did lead to future acquisitions. For example, in February 1995 Cisco formed a broad strategic alliance with NETSYS Technologies, and made a minority investment in the company. Twenty months later it acquired the whole company for its network infrastructure management and performance analysis software.

<u>Minority Equity Investments</u>		
Date	Company	Business Description
12/93	Cascade Communications	Telecommunications technology
1/95	International Network Services	Leading provider of network integration, management and consulting services
2/95	NETSYS	Developer of problem solving, modeling and simulation

10/95	Technologies CyberCash	software for network managers Leading developer of software and service solutions for secure financial transactions over the Internet
12/95	Objective Systems Integrators	Leading developer of network management software for service providers
1/96	Terayon	Cable-based digital communications
4/96	DataBeam	Provide communication and application protocols and services
4/96	Precept Software	Leading developer of networking software
5/96	Visigenic Software	Provider of standards-based database connectivity and distributed object messaging
12/96	VeriSign	Leading provider of digital authentication products and services
12/96	Interlink Computer Sciences	Leading supplier of high-performance solutions for enterprise networked systems management
12/96	OpenConnect Systems	Leading provider of internetworking software, systems and development tools

Table 5. Cisco's Minority Equity Investments (1991-1996)¹²

During this phase Cisco made 14 technology acquisitions. Given the rapid growth of the networking industry Cisco's internal technological capacity was no longer sufficient to meet demands. In 1993 it made a conscious effort to acquire key technologies that were either too expensive or too time consuming to develop in-house. Through these acquisitions Cisco was able to branch out into new product areas including Gigabit Ethernet, LAN and ATM switchers, ISDN, and network management software. All of the companies it acquired were technology leaders in their respective niche fields. Twelve out of fourteen companies were privately held. Most of the early acquisitions turned out to be very profitable. Its first acquisition, Crescendo, which Cisco bought in 1993 for \$100 million, is the foundation of a unit that grew to generate over \$4 billion in annual revenues.¹³ Many of Cisco's current core products - routers, LAN and ATM switches, dialup access servers and network management software – were acquired during this stage.

<u>Acquisitions</u>		
Date	Company	Business Description
9/21/93	Crescendo Communications	High-performance networking products
7/12/94	Newport Systems Solutions	Providing software-based routers for remote network sites
10/24/94	Kalpana	Manufacturer of LAN switching products

12/8/94	LightStream	Enterprise ATM switching
8/10/95	Combinet	Leading maker of ISDN remote-access networking products
9/6/95	Internet Junction	Developer of Internet gateway software connecting desktop users with the Internet
9/27/95	Grand Junction Networks	Leading supplier of Fast Ethernet (100Base-T) and Ethernet desktop switching products
10/27/95	Network Translation	Manufacturer of cost-effective, low maintenance network address translation and Internet firewall hardware and software
1/23/96	TGV Software	Leading supplier of Internet software products for connecting disparate computer systems over local area, enterprise-wide and global computing networks
4/22/96	Stratacom	Leading supplier of Asynchronous Transfer Mode and Frame Relay high-speed wide area network switching equipment
8/6/96	Noshoba Networks	Switching products targeted at the workgroup and backbone environments
7/22/96	MICA Technologies	High-density digital modem technology
9/3/96	Granite Systems	Standards-based multi-layer Gigabit Ethernet switching technologies
10/4/96	Netsys Technologies	Pioneer in network infrastructure management and performance analysis software

Table 6. Cisco's Acquisitions (1991-1996)¹⁴

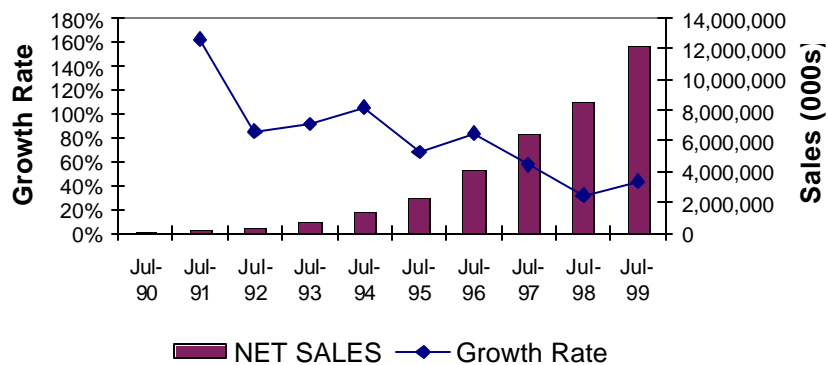


Figure 1. Cisco Sales and Growth Rate (1990-1999)¹⁵

3.3 The Discontinuities Phase (1997-2000)

As corporate intranets continued their rapid expansion, Cisco became the No.1 networking company that provided end-to-end hardware, software and network management solutions. The emergence of the Internet brought new growth potential as well as new competition. Competitive pressure became strong as more and more

companies were attracted to the network market as a result of the high profit margins and strong growth prospects. Cisco's top competitors included 3Com, Alcatel, Cabletron, Ericsson, IBM, Juniper, Lucent, Nortel and Siemens.

To maintain its technological and market leadership Cisco intensified its technology acquisition efforts. Between 1997 and 2000 Cisco purchased 42 companies in three plus years. In the first four months of the year 2000 alone Cisco bought nine companies for a record price tag of \$3 billion in total. This amount was equivalent to Cisco's fourth quarter revenue in 1999. The target companies varied in size, ranging from \$19 million to \$800 million per transaction. While Cisco's early acquisitions focused on key networking technologies such as routers and switches, the more recent acquisitions targeted a wider range of products and services. Since 1999, it has acquired companies with technologies in multimedia, e-commerce, and networking materials.

<u>Acquisitions</u>		
Date	Company	Business Description
3/26/97	Telesend	Specializing in wide area network access products
6/9/97	SkyStone Systems	Innovator of high-speed Synchronous Optical Networking/Synchronous Digital Hierarchy technology
6/24/97	Global Internet Software	Pioneer in the Windows NT network security marketplace
6/24/97	Ardent Communications	Pioneer in designing combined communications support for compressed voice, LAN, data and video traffic across public and private Frame Relay and ATM networks
7/28/97	Dagaz	Broadband networking company
12/22/97	LightSpeed	Voice signaling technologies
2/18/98	WheelGroup	Leader in intrusion detection and security scanning software products
3/11/98	NetSpeed	Customer premise equipment, central office products and broadband remote access
3/11/98	Percept Software	Leading multimedia networking software company
5/4/98	CLASS Data Systems	Allocate network resources according to company policies and priorities
7/28/98	Summa Four	Leading provider of programmable switches
8/21/98	American Internet	Leading provider of software solutions for IP address management and Internet access
9/15/98	Clarity Wireless	Leading developer of wireless communication technology
10/14/98	Selsius Systems	Leading supplier of network PBX systems for high-quality telephony over IP networks
12/2/98	Pipelinks, Inc.	Pioneer in SONET/SDH routers capable of simultaneously transporting circuit-based traffic and routing IP traffic

4/8/99	Fibex Systems	Pioneer in Integrated Access Digital Loop Carrier products
4/8/99	Sentient Networks	Developed the industry's highest density ATM Circuit Emulation Services Gateway
4/13/99	GeoTel Communications	Software solution integrates enterprise data applications with voice infrastructure devices
4/28/99	Amteva Technologies	IP-based middleware that consolidates voicemail, e-mail and fax on a single IP network
6/17/99	TransMedia Communications	Provide Media Gateway technology that unites the multiple networks
6/29/99	StratumOne Communications	Provide highly integrated semiconductor products for very high speed wide area
8/16/99	Calista	Allow legacy digital phones to interoperate with New World voice-enabled switches and routers
8/18/99	MaxComm Technologies	Enable the delivery of additional voice lines and high speed data over broadband to the home
8/26/99	Monterey Networks	Best-in-class optical transport product that focuses on the core of next-generation optical transport networks
8/26/99	Cerent	Optical transport market with next-generation products
9/15/99	Cocom A/S	European developer of standards-based access solutions over cable TV networks
9/22/99	WebLine Communications	Leading provider of customer interaction management software for Internet customer service and e-commerce
10/26/99	Tasmania Network Systems	Leading developer of network caching software technology
11/9/99	Aironet Wireless Communications	Leading developer of standards-based, high speed wireless LAN products
11/11/99	V-Bits	Leading provider of standards-based digital video processing systems for cable television service providers
12/16/99	Worldwide Data Systems	Leader in consulting and engineering services for converged data and voice networks
12/17/99	Internet Engineering Group	Leading developer of high-performance software
12/20/99	Pirelli Optical Systems	Leading developer of Dense Wave Division Multiplexing equipment
1/19/00	Compatible Systems	Leading developer of standards-based, reliable and scalable VPN solutions for service provider networks
1/19/00	Altiga Networks	Market leader in integrated VPN solutions for remote access applications
2/16/00	Growth Networks	Market leader in Internet switching fabrics, a new category of networking silicon
3/1/00	Atlantech Technologies	Leading provider of network element management software
3/16/00	JetCell	Leading developer of standards-based, in-building wireless telephony solutions for corporate networks
3/16/00	InfoGear Technology	Leading provider of Internet appliances and software used to manage information appliances for Internet access
3/29/00	SightPath	Leading provider of appliances for creating intelligent

4/11/00	PentaCom	Content Delivery Networks Leading provider of products implementing Spatial Reuse Protocol
4/12/00	Seagull Semiconductor	Leading developer of silicon technology

Table 7. Cisco's Acquisitions (1997-2000)¹⁶

Besides acquisitions Cisco has formed formal strategic alliances with prominent technology companies including EDS, IBM, Hewlett Packard, Motorola and Microsoft. Between 1997 and 2000 it participated in 71 joint ventures and alliances. The number of joint venture agreements it signed increased steadily over those four years. Of these partnerships 55% of them included joint marketing arrangements, 15% involved minority equity investments and 35% of them had joint research and development agreements. As the competition intensified, marketing alliances became more important as Cisco attempted to provide complete end-to-end hardware and software solutions to its customers. During this stage many of the strategic relationships were long-term and consisted of multiple initiatives.

	R&D	Marketing	Licensing	Equity Investments ¹⁷	Standards	Total
1997	4	4	0	6	1	14
1998	5	11	1	2	1	18
1999	9	15	1	2	1	22
2000 ¹⁸	7	9	0	1	1	17

Table 8. Cisco's Alliances and Joint Ventures (1997-2000)¹⁹

Included in its 71 alliances and joint ventures Cisco made 10 minority equity investments, involving approximately 15% of the cases. With the exception of KPMG, all the beneficiaries were technology startups. The size of investments varied, ranging from \$4 million to \$49 million. The percentage of alliances that included investments was one third of what it had done in the mature phase, suggesting that Cisco partnered more with established companies during this "discontinuities" phase.

Equity Investments		
Date	Company	Business Description
1/97	Vxtreme	Leading provider of high-quality streaming video for the Internet and corporate networks, \$4 million

3/97	Software.com	Provide high-performance, scalable server-based messaging solutions
3/97	RadioLAN	Develop low-cost wireless LANs
5/97	TIBCO Software	Leading provider of publish/subscribe software and push technologies
6/97	Global Internet.Com	Pioneer in the Windows NT network security
8/97	KPMG	Value-added consulting, assurance, tax, and process management services
2/98	Persistence Software	Develop and market the real-time event notification system
7/98	Belle Systems	Develop billing software
5/99	Portal Software	Leading provider of customer management and billing software for Internet, \$39 million
8/99	Akamai	Global Internet content delivery service, \$49 million

Table 9. Cisco's Minority Investments (1997-1999) ²⁰

Table 10. Cisco and the Four Technology Phases

	Fluid and Transitional Phase	Mature Phase	Discontinuities Phase
Dynamics of the Phase	<ul style="list-style-type: none"> * 160% growth rate * Manufactured routers that connected computers on a network * Competition very low * High growth rate as products cover a niche market 	<ul style="list-style-type: none"> * 100% growth rate * Continued rapid growth as PC market took off * Competition began to increase 	<ul style="list-style-type: none"> * 44% growth rate * Competition became intense
Priorities	<ul style="list-style-type: none"> * Establish itself as the quality producer * Gain quick market recognition * Develop technologies that can't be licensed in 	<ul style="list-style-type: none"> * Keep up with the new technologies * Pursue a growth strategy 	<ul style="list-style-type: none"> * Provide end-to-end solutions to companies * Keep up with the technological innovations
Alliances and Joint Ventures	<ul style="list-style-type: none"> * Pursued a strategy of licensing in 	<ul style="list-style-type: none"> * Active; participated in 27 alliances * 47% included joint marketing, 27% licensing agreements, 40% joint R&D, 27% supply agreements 	<ul style="list-style-type: none"> * Very active; participated in 71 alliances * 35% involved joint R&D, 55% joint marketing

Mergers and Acquisitions	* None during this phase	* 12 equity investments, most of them made alongside of alliance agreements * 14 technology acquisitions in networking technologies	* Very active * Bought 42 companies in networking, multimedia, e-commerce and networking materials * 10 minority investments, all of which were made as part of broader alliance agreements
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4. Summary and Conclusions

In this paper we studied the collaborative activities of two high-tech companies with respect to the technology life cycle. Each company operates in a distinct market sector in the computer industry: Microsoft, examined in our previous paper, is software, Compaq is hardware, and Cisco is networking. Despite the differences in their businesses, the three case studies are generally but not wholly supportive of the technology life cycle model, and demonstrate that decisions to ally or acquire by high-tech companies relate to the evolution of the technology and the market structure.

In the fluid phase companies tend to focus on improving product functionality and gaining quick market recognition. The model proposes that companies are expected to form marketing alliances with key players of the supply chain or with one industry leader. Companies can also form standards alliances and adopt a variety of licensing strategies. In its fluid phase Microsoft established an important strategic relationship with IBM. With its dominance in the mainframe market IBM was able to quickly establish its PC as the dominant design. With its operating system quickly recognized as the industry standard Microsoft adopted an aggressive licensing strategy during this stage, and its first customers included big corporations such as General Electric and Citibank. Compaq Computer entered the fluid phase with the dominant technologies from IBM and Microsoft. It made several agreements to license in the necessary technologies. As most of its products were sold through channel distribution, it did not participate in marketing alliances during this phase. In its fluid phase Cisco encountered very little competition and rapid growth. Its router technologies covered a niche marketplace. Cisco was not very active in either alliances and acquisitions during this stage. It made several marketing and supply agreements and no acquisitions. During the fluid phase only Microsoft really did what the model had expected it to do. Neither Compaq nor Cisco

aggressively marketed its technology to others. Compaq entered the market with other firms' technologies already recognized by the market, and Cisco's technology was pioneering enough for the market to come to the technology.

In the transitional phase the model asserts that high-tech firms are expected to form joint R&D ventures, adopt aggressive licensing strategies to realign their technology portfolio, and sign marketing and supply agreements to guarantee consistent quality, price and availability. Microsoft indeed carried on its aggressive licensing strategy, and the strategic alliance with IBM continued to be instrumental to Microsoft's growth. As Microsoft's dominance was recognized by the financial market, it made its first acquisition with its soaring stock, adding an application software program that fit nicely with Microsoft's family of office products. During its transitional phase Compaq Computer pursued a growth strategy as expected by the model. It formed several supply agreements, joint marketing alliances and joint R&D ventures. Like Compaq, Cisco was only slightly more active in alliances at this stage than during the fluid phase. All three companies behaved somewhat differently from the predictions of the life cycle model. Microsoft did indeed pursue an aggressive licensing strategy, but it did very little in terms of joint R&D and marketing. Both Compaq and Cisco remained quite inactive during this phase, which is puzzling. Even with the dominant technology, firms were expected to participate in joint R&D and marketing alliances.

In the mature phase of the technology life cycle, firms are expected to be very active in alliances, joint ventures and acquisitions. They are presumed to form joint R&D ventures to share risks and costs of technology development. They can use manufacturing alliances to assure availability of essential products and form marketing alliances to attack latent markets. Indeed Microsoft engaged in 36 joint ventures and alliances during this stage. Of these partnerships 61% involved joint research and development ventures and 39% included joint marketing agreements. The technology ventures allowed Microsoft to access the most advanced technologies in the field. Microsoft's partners included most of the leading hardware companies at the time. During its mature phase Microsoft made several minority equity investments and two acquisitions in the application software area. The competition against Compaq intensified in 1990 as clone makers began to offer the same technical quality at a lower price. In addition to its

internal efforts at cost control, Compaq began during its mature phase to participate in a broad range of collaborative activities. From 1990 to 1995 it took part in 65 joint ventures, the majority of which were supply agreements and marketing alliances. To keep up with the rapid technological changes in the computer industry, it engaged in 31 joint research and development ventures. Originally a router company, Cisco branched out into virtually every market segment in the networking area through acquisitions during this stage. Cisco made 14 technology acquisitions as its internal technological capacity was no longer sufficient to meet demands. The majority of its target companies were privately held. During its mature phase Cisco participated in 27 joint ventures and made 12 minority equity investments. Forty percent of its alliances included investments, suggesting that many of Cisco's partners were technology startups. Of Cisco's 27 strategic partnerships 47 % included joint market arrangements and 40% involved joint R&D ventures. As the model predicts for the mature phase, all three companies actively engaged in alliances, namely joint R&D ventures and joint marketing agreements. Both Microsoft and Compaq began to make equity investments and acquisitions, but their actions were limited. Cisco, on the other hand, made a conscious effort to acquire technologies it was not able to develop in-house. The proliferation of alternative networking technologies was the rationale behind Cisco's strategy.

As the technology enters the discontinuities phase firms are expected to participate in marketing and licensing agreements as well as joint R&D ventures. This is also a stage of high product and market uncertainty with invading technologies and converging markets. The emergence of the Internet changed the competitive landscape in the computer industry, and Microsoft entered its phase of technological discontinuities in 1996. Realizing the threat of new technologies, it became increasingly active in its alliance and acquisition efforts. Since 1995, Microsoft participated in 35 alliances and joint ventures with 46% involving joint R&D and 51% including joint marketing agreements. As the market became more volatile, more emphasis was given to maintaining customer relationship and providing comprehensive solutions to clients. Given its strong financial strength Microsoft made 26 minority investments and acquired 15 companies between 1995 and 2000. Most of its acquisitions and equity investments were Internet-related, ranging from services to content. Similarly, Compaq's growth rate

slowed down during the second half of the 1990s as the company entered its phase of technological discontinuities. Several key competitors had established themselves as the industry innovators with new business models. In an effort to strengthen its leadership position, Compaq became far more active in alliances and joint ventures. Since 1996, the company participated in 68 alliances and joint ventures, representing an annual increase of 55% over its mature phase endeavors. The distribution of these alliances was similar as Compaq continued to focus on customer relationships. Given the low profit margin of the PC market during the commoditization that occurred in the mature phase, Compaq began to expand its business into new product areas through acquisitions. It bought three computer hardware companies (DEC, Tandem and Microcom), each acquisition offering Compaq entry to a higher margin niche market, before Compaq itself was acquired in a major controversial undertaking by Hewlett-Packard. As corporate intranets and the Internet continued rapid expansion, competitive pressure began to mount in the global networking market. Cisco's top competitors included Lucent, Nortel and IBM. To maintain its technological leadership Cisco intensified its technology acquisition efforts. From 1997 to 2000 it bought a record of 42 technologies companies, ranging from multimedia to silicon material. With these acquisitions Cisco transformed itself into a complete end-to-end networking company. In addition it participated in 71 alliances and joint ventures and made 10 minority investments. Of these partnerships 55% included joint marketing arrangements and 35% had joint R&D agreements.

Contrary to the model's expectations all three companies were more active in alliances and in mergers and acquisitions during this discontinuities phase than during the mature phase. The companies in the three case studies were all leaders in their respective technology sectors. They tend to have strong financial resources. In a period of technological discontinuities they are willing to invest to defend against attackers while entering into the new growth market. All three participated in a high number of joint R&D and marketing alliances as predicted by the model. The pattern of acquisitions and equity investments is very similar to the model's prediction as well.

In many aspects the case studies were supportive of the technology life cycle model. In particular, the firms' behaviors in the mature and discontinuities phases corresponded well to the theory. For the most part the companies in the case studies

seemed to lack collaborative activities in the early stages of technology. Yet we need to take into consideration that these initial stages of industry-technology emergence took place 20 years ago. The technology life cycle model seems somewhat biased toward more current events. The correspondence of theory and case ought to be best when the firm is closest to being a single technology homogeneous entity. The early stages of Microsoft and Cisco are good proxies for single technology firms, and yet Cisco shows none of the expected collaborative acts during its fluid and transitional periods. As the firm grows larger and more successful, its tendency toward broadening its technological (and markets) base weakens the direct applicability of the technology life cycle model. Given these reservations, the case studies do add important insights to the phenomena of technological evolution.

Endnotes

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³ Roberts, Edward B. and Liu, W. Kathy, "Ally or acquire? How technology leaders decide?" *MIT Sloan Management Review*; Fall 2001 (vol. 43, no. 1), 26-34..

⁴ The PC industry went through a truncated fluid phase as the IBM PC was recognized as the industry standard soon after its introduction. In 1981 the IBM PC debuted with Microsoft's Disk Operating System (MS-DOS). Given IBM's strong control of the mainframe market, no one challenged the new technology and it easily became the industry standard. Other computer companies immediately set out to clone this new hardware standard. The industry entered its transitional stage without a battle for standards.

⁵ <http://www.heuse.com/1982.htm>

⁶ Disclosure financial database, <http://www.disclosure.com>

⁷ Utterback, James M., *Mastering the Dynamics of Innovation* (Boston: Harvard Business School Press, 1994).

⁸ SDC database

⁹ Compaq Computer, Press Release Archive, <http://www.compaq.com/newsroom/pr/1997/pr230697a.html>

¹⁰ http://doc.altavista.com/company_info/about_av/background.shtml

¹¹ The dynamics for the fluid stage and transitional stage for Cisco did not change much at all. The discussion is therefore combined.

¹² Cisco Systems, Official Press Releases, <http://www.cisco.com>

¹³ Cisco homepage, <http://www.cisco.com>

¹⁴ Cisco Systems, Official Press Releases, <http://www.cisco.com>

¹⁵ Disclosure financial database

¹⁶ Cisco Systems, Official Press Re leases, <http://www.cisco.com>

¹⁷ All of these equity investments are part of the more comprehensive alliance agreements.

¹⁸ January to April 30.

¹⁹ SDC Database

²⁰ Cisco Systems, Official Press Releases, <http://www.cisco.com>

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